

## **SITE INVESTIGATION RESULTS AND RESPONSES TO AGENCY COMMENTS**

for the

# **SOUTH CAROLINA AQUARIUM SITE**

Charleston, South Carolina

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Prepared for:  
City of Charleston

December 1994

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#### NOTE

This report is a compilation of two reports which were previously published in connection with the South Carolina Aquarium Project. These are the Site Investigation Results and Conceptual Containment Plan, dated June, 1994, and Response to Comments on ... (the report cited above), dated August, 1994. Two chapters (7.0 - Containment Plan and 8.0 - Monitoring and Response Plan) have been omitted from this compilation since they have been published separately.

The entire contents of the response document cited above has been included herein, although some of the concepts which are discussed in the responses have been further developed since their original publication in August, 1994. The current containment plan and environmental monitoring and response plan have been published as stand-alone documents, dated December, 1994.

## EXECUTIVE SUMMARY

### Introduction

This report presents the results of a site investigation conducted at the future site of the South Carolina Aquarium, located on Concord Street in the City of Charleston. A containment plan, designed to prevent or minimize the release of contaminants from the site during construction, is also included in this report. The need for and the basis of the containment plan has been determined by the findings of the site investigation.

### Background

The Aquarium Site is a 1.5 acre parcel which straddles the intertidal zone of the Cooper River. It is part of a larger parcel owned by the National Park Service ("NPS") and known as the Charleston Harbor Site ("CHS"). Concerns have been raised by NPS in connection with potential contaminant releases to the environment from the Aquarium Site during construction of the Aquarium.

In 1941, much of the CHS, formerly open water or mud flats, was filled and incorporated into a Navy shipyard. Also, the Calhoun Park Area ("CPA") Site, a former manufactured gas plant now under investigation by EPA, lies immediately to the northwest of the CHS. Recent investigations in and around the CHS have revealed areas of contamination, principally by metals and polynuclear aromatic hydrocarbons ("PAHs"), some of which may have migrated from the CPA Site, and some of which may have originated from the filling and other shipyard activities.

Since the City wishes to proceed with construction of the Aquarium before any remediation of the CPA site or the CHS takes place, it has retained Killam Associates to undertake a very comprehensive and detailed investigation of the Aquarium Site, to determine the nature and extent of the contaminants present on the site. The elements and conditions of this site investigation were specified by NPS in a document known as the "PSI Workplan".

The data from this investigation are to be used in the preparation of a Containment and Contingency plan designed to prevent or minimize the release of contamination to the environment (principally surface water) as a result of the construction. This Plan, outlined conceptually in this report, includes methods of containing the discharge of contaminants to the Cooper River during and after construction. In addition, the plan will minimize the discharge of contaminants to adjacent land areas as well as to the atmosphere. The plan also includes elements to monitor the effectiveness of the containment, and to respond to any releases.

### Site Investigation

The Aquarium will be constructed on 350 concrete piles. Soil and sediment borings were installed at locations corresponding to the intended placement of those piles. The 66 upland soil borings were extended to a depth of -75 ft. MSL, corresponding to the depth to which 18 inch

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diameter holes would be augered prior to driving the piles, and samples were collected every 5 ft. In addition, 25 soil borings were placed in the intertidal portion of the site, and were extended to the same depth. Soil samples were taken every two feet for the first ten feet of depth, and then every 5 ft. Forty sediment samples were taken from twenty sampling locations in the subtidal area of the site. One groundwater sample was taken from each of two existing shallow monitoring wells and from one newly installed deep monitoring well. One surface water sample was taken from the Cooper River.

All groundwater, surface water, sediment and QA/QC samples taken were submitted for laboratory analysis. However, only select soil samples were analyzed. Approximately three to four soil samples from each of 91 borings were submitted for analysis. In general, random soil samples (samples from each boring location at randomly selected depths) were "preselected" for analysis. However, if soil samples exhibited characteristics of contamination through specified field screening procedures, the apparently contaminated samples were substituted for the preselected samples. Similarly, the selection of specific sediment samples from the four foot core was biased in favor of the specific sample intervals which exhibited indications of contamination in the field.

It must be stressed that this approach is fundamentally different from site investigations in general, and from the site investigations of surrounding properties in particular. For this reason, great care must be taken when attempting to compare the data in this report with those generated for other related site investigations. Specifically, the selection of many samples in this investigation involved a deliberate bias, whereby samples of the most highly contaminated soils and sediments were collected for laboratory analysis based on visual and field screening procedures. By following this protocol, the most contaminated samples make up a high percentage of overall data set, and represent worst case conditions. In contrast, other site investigations, such as Remedial Investigations, do not specifically select the most contaminated samples for analysis, but attempt to provide a representative picture of overall conditions at a site.

Analytical parameters included full TAL/TCL analysis for some samples and a "short list" (PCBs, PAHs, BTEX, and PP Metals) for others. Thirty-four soil and sediment samples were also analyzed for dioxins and dibenzofurans. Some of these were analyzed for the full suite of congeners, others for 2,3,7,8-TCDD and -TCDF only.

Formal data validation of the analytical results was not included in the scope of the PSI Workplan. However, in order to verify that the data generated are valid and usable, a data quality assessment was performed by reviewing the non-conformance summary sheets and case narratives provided by the laboratories.

### Investigation Results

All data resulting from the investigation were screened to eliminate data which reflected uncontaminated conditions, and to retain data which characterized contaminated portions of the site. This was done by establishing a screening level for each contaminant. The screening level was the lowest contaminant level included in up to five sets of limits or criteria selected by Killam for guidance purposes. These included residential action levels established by EPA Region III; selected remedial goals for two unrelated manufactured gas plant sites; draft marine sediment quality criteria established by EPA for five non-ionic organic chemicals; and contaminant concentrations associated with adverse biological effects collected and published by Long and MacDonald.

For each segment of the site (upland soils, intertidal soils, sediments, etc.) the highest levels of contaminants found were identified. In some cases, the averages of all reported values were calculated. For shallow intertidal soils and subtidal sediments, these were compared to Long and MacDonald biological effects concentrations.

Since the data set consists of two separate and distinct groups of data (representing randomly selected samples and biased samples), common statistical descriptors, such as arithmetic averages do not accurately represent the overall levels of contamination found at this site. *For example, the average value of total PAH is 145 mg/kg. However, the average value of total PAH for randomly selected samples is 12.6 mg/kg while the average value of the deliberately selected samples is 255 mg/kg.*

For the upland soils, Horizon A (all soils above +3 ft. MSL), PAHs and metals were present at levels requiring containment. For upland soils, Horizon B (all soils which will be excavated for the construction of pile caps), the analogous constituents were PAHs, free hydrocarbon product, and metals. For upland soils, Horizon C (all soils below Horizons A and B), the constituents were PAHs, free hydrocarbon product, PCBs, and metals.

For shallow intertidal soils (less than 10 feet deep), PAHs, free hydrocarbon products, PCBs and metals were present in some samples at levels requiring containment. For the deep intertidal soils (greater than 10 feet deep), the analogous constituents were PAHs and free hydrocarbon product.

For sediments, PAHs, free hydrocarbon product and metals were present at levels requiring containment.

For groundwater, the shallow samples exhibited low levels of metals. The concentration of dissolved PAH was somewhat above the screening level in the sample results. All of the contaminants identified in the single deep groundwater sample were present at low levels. The surface water sample contained trace concentrations of metals, and did not contain PAHs, pesticides, PCBs, or volatiles (except for a laboratory artifact).

### Hydrogeological Assessment

The purpose of the hydrogeological assessment was to determine whether a significant change in contaminant distribution or contaminant flow pathways is likely to be caused by the construction activities at the Aquarium site, or by conditions consequent to the construction.

This analysis identified two water bearing units or aquifers of importance at the Aquarium site. The first is the unconfined water table aquifer which occupies the shallow fill material. This fill is generally less than 20 feet deep across the site. The second is a silty and clayey sand unit, approximately 40 feet deep. The hydraulic gradient at the site is downward. The lower sand unit is well connected hydraulically to the Cooper River, since the river channel intersects this unit, and the interface is kept open by periodic dredging. On the other hand, the direct discharge of the fill aquifer to the Cooper River is somewhat restricted due to a reduced cross sectional area as the fill approaches the river, and due to "plugging" of the fill by tarred sands which occur in the area of the intertidal zone.

Since the upper fill aquifer contains higher levels of dissolved PAH than the sand aquifer, the potential for discharging water from the fill to the sand aquifer via open boreholes (resulting from preaugering) was evaluated and modeled. It was determined that the hydraulic gradients equalize very quickly, which reduces the flow through an open borehole. Given the short period of time in which the borehole will remain open (generally not longer than 30 minutes), the volume of water which will be transferred between aquifers is estimated at less than 45 gallons per borehole. This is not generally considered to be significant.

Downward smearing of product along boreholes or piles may occur to an extent. However, hydrocarbon product is already known at depth across the site, with little effect on dissolved groundwater quality.

Excavation of debris which is present in the intertidal zone may remove obstacles currently restricting discharge of the fill aquifer near its intersection with the river. Localized containment measures to avoid increased discharges of the fill aquifer to the river are advisable and provided for in the Containment plan.

### Containment Requirements

Based on the results of the site investigation, it is recommended that all horizons of upland soils should be contained with respect to the Cooper River, adjacent land areas and the atmosphere. Construction workers should be protected by an appropriate Health and Safety Plan. Intertidal soils should also be contained with respect to discharge to the Cooper River and tracking onto adjacent land areas. Subtidal sediments should be contained with respect to discharge to the Cooper River. The need for containment of groundwater is limited. An attempt should be made to minimize any potential increase in the discharge of water from the fill aquifer to the river.

### Containment Plan

The Containment Plan for the Aquarium was developed based on the results of the site investigation and the potential risk of release of contaminants to the environment. The provisions of the containment plan will minimize any releases, and are designed to be protective of human health and the environment. The Containment Plan will be implemented in conjunction with a monitoring plan which will measure the effectiveness of the various containment provisions in the field. Any modifications or upgrades to the containment provisions indicated by unforeseen situations during the construction process will be implemented as needed.

The "Waterside" containment system will limit the migration of sediment, soil and debris to the adjacent river during construction. The containment system will consist of three elements - a sand blanket, a timber lagging wall, and a silt curtain. The sand blanket will be several feet thick. It will form a cap over the construction area and will act as a sand filter trapping disturbed sediments beneath it. The sand blanket will be placed in the intertidal and subtidal portions of the site.

The timber lagging wall will contain soils and sediments from the intertidal and upland areas of the site. It will be located at or near the low tide mark. The area between the timber lagging wall and the high tide mark will be filled with sand. This will permit excavation, augering and pile driving to occur above the waterline. The wall will act as a bulkhead between the filled intertidal zone and the sloped sand blanket extending toward the river. The wall will be constructed of steel "H" section piles driven into the underlying sediments, with timber cross members. The landside face of the wall will be lined with 40 mil PVC to resist the exchange of water across the wall by tidal action.

The silt curtain will surround the entire waterside of the site. Its purpose is to contain waterborne silts from construction and to contain sand from the sand blanket which is disturbed during construction. The silt curtain will consist of a floating boom, suspending sections of filter fabric which are weighted to the bottom. A separate absorbent floating boom will be attached to the inside of the silt curtain assembly to collect any surface sheens which may occur.

The groundwater containment plan is intended to minimize the discharge of water from the fill aquifer to the sand aquifer during preaugering. In addition, this plan is designed to minimize any discharges of hydrocarbon product and soil/sediments to the Cooper River, and to discourage the transport of contaminants within the upper fill unit by groundwater. The primary elements of the groundwater containment plan include minimization of the amount of time that a preaugered borehole will remain open, installation of the timber lagging wall, use of sheeted excavations to minimize the pumping of water during dewatering, and use of additional barriers ("water stops," sheet piling) to retard groundwater flow.

The "Landside" containment plan is intended to prevent the transport of soils offsite. To accomplish this, the plan provides for the containment of soils, sediments, and stormwater within

the site to prevent contaminant migration via erosion, surface runoff, and vehicle tracking. Landside containment measures include erosion control, stormwater and sediment control, and vehicle decontamination.

Containment of discharges to the atmosphere will be provided by a Dust Control Plan. This plan will minimize the creation and dispersion of contaminated dust, vapor and air-borne sediment. Potential mechanisms for control of these emissions will include the use of water, calcium chloride, chemical spray adhesives, mulch, and windscreens.

#### Monitoring Plan

The purpose of the monitoring plan is to ensure compliance with the containment plan. The monitoring plan will consist of visual inspections of containment control devices, instrumented real-time monitoring of some environmental parameters, and laboratory analysis of samples which will be collected on a periodic basis during construction. Specific details of the program will vary with the medium being monitored.

#### Conclusion

The contamination identified at the Aquarium Site can be contained during construction of the Aquarium. The Containment and Monitoring Plans which have been developed will minimize releases or dispersion of contaminants beyond the site perimeter during and following construction of the South Carolina Aquarium.

## 1.0 INTRODUCTION

This report presents the results of a site investigation performed at the future site of the South Carolina Aquarium, which is located at 350 Concord Street in the City of Charleston. On the basis of the data generated in the site investigation, a conceptual containment plan is also presented in this report. This containment plan is designed to prevent, or minimize the potential for, the release of contaminants from the site to the surrounding environment.

The Aquarium Site consists of a 1.5 acre parcel, which is currently part of a larger parcel owned by the National Park Service (NPS). The City intends to execute a lease with the NPS which would permit the City to construct the Aquarium. The NPS parcel is known as the Charleston Harbor Site (CHS) and is bordered on the east by the Cooper River, on the west by Concord Street, on the north by Luden's Marine, on the south by Dockside Condominiums, and on the southeast corner by a parcel owned by George E. Campsen.

The CHS is situated in proximity to a site being investigated under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), encompassing the South Carolina Electric & Gas (SCE&G) Substation property, Ansonborough Homes, and Calhoun Park, collectively referred to as the "Calhoun Park Area Site". The South Carolina Department of Health and Environmental Control (SCDHEC) completed a Site Screening Investigation (SSI), dated June 4, 1992, and gave the Calhoun Park Area Site a "HIGH" priority rating. A Remedial Investigation (RI) for the Calhoun Park Area Site is currently being prepared for SCE&G and is documented in the Preliminary Site Characterization Summary (Chester Environmental, April 1994). The full RI report is expected to be completed in July, 1994.

Due to the potential influence of the Calhoun Park Area Site on the Aquarium Site, the findings of previous investigations at the CHS, and the prior industrial use of the Aquarium Site itself, the NPS has required, prior to granting a lease to the City, that the City investigate the levels of contaminants potentially present at the Aquarium Site. This investigation is being conducted in accordance with a work plan prepared by Professional Service Industries, Inc. (PSI) on behalf of the National Park Service (Workplan Soil, Sediment, Surface Water and Groundwater Investigation, Aquarium Tract, Charleston Harbor Site, prepared in May 1993 and modified in September, 1993 referred to herein as the "PSI Workplan" or "Workplan").

It must be stressed that the site investigation which is documented in this report is fundamentally different from site investigations in general, and from the site investigations of surrounding properties in particular. For this reason, great care must be taken when attempting to compare the data in this report with those generated for other related site investigations. Specifically, the selection of many samples in this investigation involved a deliberate bias, whereby samples of the most highly contaminated soils and sediments were collected for laboratory analysis based on visual and field screening procedures. By following this protocol, the most contaminated samples make up a high percentage of the overall data set. In contrast, other site investigations, such as Remedial Investigations, do not specifically select the most contaminated samples for analysis. Instead, samples for laboratory analysis are usually taken from a random grid, in

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combination with samples representing specific areas of concern, pathways for contaminant migration, limits of contaminated zones, and background conditions. The data set for such other site investigations would be expected to include a much higher percentage of uncontaminated samples.

In addition to this site investigation, the NPS has also required that the City prepare a "Containment and Contingency Plan," which would mitigate any releases to the environment as a result of the construction of the Aquarium and the presence of the completed building on the site. The mitigating effects of the Containment and Contingency Plan will also be considered by the NPS.

Killam Associates was retained by the City to implement the detailed sampling and analytical program at the site, as specified by the PSI Workplan. The purpose of this Workplan was to document the highest levels of contaminants present in the soil and sediments in those parts of the site which would be affected by the proposed construction. In addition, limited sampling of groundwater and surface water was included in the plan.

In addition to the site investigation, Killam was also retained to develop a plan (a "Containment and Contingency Plan") to contain contaminants present at the site which could be released during construction. This plan would be implemented as a part of the construction of the Aquarium; its design would be based on the results of the investigatory effort; and it would also be considered by the Park Service in their assessment of the risk of a contaminant release.

The Containment and Contingency Plan included in this report consists of the following components:

1. A "Waterside" containment plan, which is intended to minimize the risk of a discharge of contaminants to the Cooper River, e.g., by resuspension of contaminated sediment particles, and the discharge of surface runoff.
2. A "Groundwater" containment plan, which is intended to minimize the risk of a discharge of contaminants to the Cooper River from waterbearing aquifers beneath the site, and of discharges from contaminated aquifers to clean aquifers.
3. A "Landside" containment plan, which is intended to prevent the migration of contaminants off-site, from common sources such as tracking of soil onto streets and adjacent land areas. This plan will also serve to contain runoff within the site.
4. An "Air" containment plan, which is intended to minimize the risk of discharges of contaminants, such as volatile substances and contaminated dust particles, to the atmosphere, to the extent that such a pathway poses a risk of release.

5. A Monitoring Plan, which is intended to assess the effectiveness of recommended containment strategies in the field during the construction process.
6. A Response Plan, which will provide for appropriate additional containment responses in the event that a discharge occurs during construction.
7. A Construction Health and Safety Plan, which will provide for protection of workers involved in the construction project.

The development of the various containment plans is being guided by the findings of the site investigation, the hydrogeological assessment, and the design of the project. That is, if the investigation indicates the presence of contamination and if pathways to the environment are present, then containment mechanisms are indicated.

This report contains an assessment of the chemical data generated by the site investigation, a hydrogeological assessment of the site, an analysis of pathways open to contaminant release, and conceptual plans for waterside, landside, groundwater, and air containment. In addition, the conceptual framework for the monitoring plan is also presented.

Section 1.0 of this report provides background information and briefly describes the scope of work of the investigation. This section also documents some refinements of the basic Workplan, which were made prior to initiation of the field work, in concert with the concerned regulatory agencies (specifically the National Park Service, the U.S. Environmental Protection Agency and the South Carolina Department of Health and Environmental Control). Section 2.0 of this report presents a description of the field procedures utilized and the observations made during the field investigation. Section 3 presents the analytical results of the soil, sediment, groundwater and surface water samples collected. Section 4 presents a review of the analytical QA/QC documentation provided by the laboratories that performed the analytical work. Section 5 presents the results of a hydrogeological assessment of the groundwater pathways which underlie the site. Section 6 summarizes existing pathways and contaminant patterns. Finally, Section 7 and Section 8 present conceptual containment and monitoring plans which are designed to prevent or minimize the discharge of contaminants to the surrounding environment.

As required in the PSI Workplan, a site specific Health and Safety Plan (HASP)/Contingency Plan and a Quality Assurance/Quality Control (QA/QC) Plan were prepared for this site investigation, and were reviewed and approved by the City of Charleston and the NPS prior to the initiation of field work at the site in January 1994. Specific information on the scope of work, field procedures and Quality Assurance/Quality Control protocols were included in a document entitled Quality Assurance/Quality Control Plan for the Soil, Sediment, Surface Water and Groundwater Investigation, South Carolina Aquarium Site, dated November 1993. The Health and Safety Plan was concurrently submitted as a separate document entitled Health and Safety Plan/Contingency Plan for the Soil, Sediment, Surface Water and Groundwater Investigation, South Carolina Aquarium Site, November 1993.

## 1.1 Site Description and History

(Sections of the Site Description and History are excerpted from the PSI Workplan.)

The Aquarium Site location is shown on Figure 1-1. The Aquarium will be located on the northeast corner of the CHS and will be situated partly over the upland portion of the site, partly over the intertidal zone of the Cooper River, and partly over the open water of the River (Figure 1-2). The Site encompasses 1.5 acres and is currently clear with no structures. A portion of the Aquarium Site is submerged in the Cooper River which is subject to tidal fluctuations at this location. The groundwater table is approximately two (2) to four (4) feet below land surface (bls) and is tidally influenced. According to historical documents, the Aquarium Site was previously submerged within the boundaries of the Cooper River. From the late 1700's onwards, the western and southern perimeters of the CHS (but not the Aquarium Site) were filled and developed for commercial use. In the early 1940's, the majority of the CHS (including the upland portion of the Aquarium Site) was filled with material of unknown origin, and was used as part of a shipyard serving the U.S. Navy. Prior to this time, the western and southern perimeters of the CHS had a variety of commercial/industrial uses, as a part or parts of the following:

- shipping wharf
- lumber yard
- warehouse for shipping goods and for naval stores

The CHS, including the Aquarium Site itself, was used for various ship building activities during World War II, as part of a larger shipyard extending southward to Lauren Street. After the 1940s, shipbuilding ceased, and the facilities on the CHS appear to have fallen into disrepair, while ship repair activities continued in the remainder of the shipyard into the 1970s. The CHS was most recently used as a soccer field.

Many of the adjacent parcels have industrial/commercial histories that date back to the eighteenth or nineteenth centuries. The SCE&G Substation property is the previous location of a former manufactured gas plant (MGP) which operated from the 1800's to the mid-1950's. During the manufacturing of gas, light and heavy coal products, coal tar, and coke were produced as by-products. The handling and disposal of these by-products are unknown.

## 1.2 Investigation Workplan and Amendments to the Workplan

The PSI Workplan (included in Appendix A) required extensive soil sampling in the upland and intertidal areas, and sampling of Cooper River sediments, groundwater, and surface water, as described below.

### 1.2.1 Upland Soils

Sixty six (66) soil borings were required in the upland areas of the Site at locations corresponding to, or adjacent to, the locations of the future pilings and utility platform for the Aquarium. The borings were to be installed to 75 ft. below mean sea level (MSL), or an average depth of approximately 79 ft. below grade. With the exception of five borings, all upland borings were installed to the required depth. Five borings (B-5, B-6, B-41, B-56 and B-68) were terminated with NPS approval at shallower depths (ranging from 35 ft. to 57 ft.), because physical obstructions prevented the advancement of steel casing needed to isolate strata contaminated with hydrocarbon product, as discussed in detail in Section 2.

Soil samples were obtained from three separate horizons, as required in the Workplan. The first horizon (Horizon A) extends from existing grade to 3 ft. above MSL. This depth corresponds to the finished grade elevation of the proposed Aquarium building. The second horizon (Horizon B) encompasses the zone which will have to be further excavated to allow concrete pile caps to be installed. This second horizon extends from 3 ft. MSL to the bottom of the pile caps, which vary in depth. The third horizon (Horizon C) extends from the bottom of the pile caps to 75 ft. below MSL, the depth to which piles will be pre-augered.

As specified in the Workplan, soil samples were collected from the three horizons as follows: one composite sample from Horizon A, one discrete sample from Horizon B, and discrete samples collected at 5 ft. intervals in Horizon C. All samples were field screened using a photoionization detector (PID) and visual inspection. **Samples were selected for laboratory analysis if either PID screening or visual inspection of the split spoon sample clearly indicated contamination.** A clear indication of contamination was defined as one of the following: a) PID reading of 5 ppm or more above background; b) a visual observation of hydrocarbon-stained or hydrocarbon-saturated soils; or c) clear evidence of other types of contamination by potentially hazardous materials, e.g. paint pigment. These criteria for sample screening were approved by the NPS in a letter dated January 19, 1994 (included for reference in Appendix A).

A modification of the sampling strategy provided in the PSI Workplan was made to satisfy a concern on the part of the EPA that laboratory analysis of only clearly contaminated samples would not yield a representative data set. Thus, the resulting data set could not appropriately be used to characterize the overall quality of soil and sediments at the site, as it would only document the highest levels of contaminants found. Consequently, the following change to the PSI Workplan (documented in the January 19, 1994 letter from the NPS, included in Appendix A) was made prior to initiation of the field work.

Three sample depths, out of an average of 18 per boring, were randomly preselected for laboratory analysis. Two of these sample depths were preselected from the entire depth of the boring. The third was randomly preselected from the upper two horizons only. The three sample depths were randomly assigned the priority letters A (highest priority), B, and C (lowest priority). The preselected samples were prepared for laboratory analysis without regard to the sample screening results. Samples which clearly indicated contamination were also prepared for

laboratory analysis. At the completion of each soil boring, samples were chosen for shipment to the laboratory. Any sample selected for laboratory analysis on the basis of sample screening preempted one of the preselected samples. The preselected samples were replaced starting with the lowest priority letter. The randomly preselected sample depths are indicated on the boring logs contained in Appendix B.

In cases where repeated contiguous soil intervals clearly showed continuous contamination, some of the samples taken from such a zone were either replaced by the preselected samples for laboratory analysis, or otherwise excluded from laboratory analysis at the discretion of the on-site NPS representative. Samples selected for laboratory analysis were dispatched to the laboratory only after reaching agreement with the on-site NPS representative (Mr. Peter Vogel of Law Environmental, Inc.).

In general, 3 to 4 soil samples (with a minimum of 3) were analyzed per boring. A minimum of three samples was also collected from the five borings which were terminated at shorter depths. At location B-32 only two samples were analyzed, as PSI (on behalf of the NPS) collected additional samples for laboratory analysis from this location. This change was approved by the City prior to the completion of the boring.

Some minor relocation of sampling points was necessary due to field conditions. Figure 1-3 and Figure 1-4 indicate the actual location of all sampling points.

### 1.2.2 Intertidal Soils

The PSI Workplan called for the installation of 25 soil borings to a depth of -75 ft. MSL in the intertidal area. With the exception of four borings, all intertidal borings were installed to the required depth. Four borings (B-80, B-81, B-82 and B-86) could not be installed due to the presence of heavy, continuous metallic debris at these locations. This debris appeared to consist of gun turrets which were placed at the edge of the intertidal zone to stabilize the shore line. Relocation of these borings to avoid this debris-filled area would have resulted in boring locations which were already occupied by adjacent borings. In lieu of soil borings, samples were collected from an excavation performed with a track-hoe at each of these locations. At least 1 sample was collected and analyzed from each of these locations. Three to four soil samples were analyzed from the remaining intertidal borings.

The intertidal borings were installed using a procedure developed in response to the observation of some hydrocarbon-saturated soils in the upland area. The modified procedure (described in the Addendum to the Quality Assurance/Quality Control Plan and the Health and Safety Plan/Contingency Plan dated March 1994, included in Appendix A) was approved by the NPS and the City of Charleston prior to the initiation of the intertidal work. Approval for this procedure (described in Section 2) was provided in a letter dated April 8, 1994 (Appendix A).

The first 10 ft. of soil at the intertidal locations were sampled at 2 ft. intervals. In general, the shallow samples were obtained from excavations installed with a track-hoe. Soils below 10 ft.

were sampled at 5 ft. intervals within each soil boring, using a split spoon sampler. As in the case of the upland borings, 3 samples per boring were initially randomly preselected for laboratory analysis, and subsequently replaced by any samples selected for analysis on the basis of field screening.

Some minor relocation of sampling points was necessary due to field conditions. Figure 1-3 indicates the actual location of all sampling points.

### **1.2.3 Sediments**

The sediment quality in the subtidal area of the Cooper River, where concrete piles will be driven (without preaugering) to approximately 98 ft. below MSL, was investigated by the collection of sediment samples in each of twenty (20) locations.

The PSI Workplan required that two samples be collected at each location, "one at the river bottom, and one at 2 to 3 ft. below the river bottom". During the field sampling program a request was made by the on-site NPS representative that samples of the two most visibly contaminated segments of each 4 ft. core should be selected for laboratory analysis. Consequently, all sediment samples were collected using this biased approach.

### **1.2.4 Groundwater and Surface Water**

Groundwater quality in the upland region was investigated by the installation of one double-cased groundwater monitoring well (MW-KA1). As required by the PSI Workplan, this well was screened in a sand stratum occurring within the less permeable silt, silty clay, clay and sandy clay which underlie the fill material. The well was screened from 39.5 ft. to 49.5 ft. below ground surface.

A well log for MW-KA1 is included in Appendix B. Well logs for the other two monitoring wells on the Aquarium Site (previously installed by General Engineering Laboratories in 1992), are also included in Appendix B for reference. A representative geologic cross section for the site is shown in Figure 1-5.

A minor adjustment to the location of monitoring well MW-KA1 was required due to the presence of a large debris pile in the location proposed in the Workplan. Verbal approval for relocating the well was obtained from Mr. Carl Wang of the NPS in the field. The well was installed in the location shown on Figure 1-3. The well was installed under the SCDHEC Approval Number SF-94-0006.

The new monitoring well and the existing two shallow monitoring wells were sampled in accordance with the requirements of the PSI Workplan. The surface water quality in the Cooper River directly downstream of the Aquarium Site was investigated by the collection of one grab sample from the River, as required in the Workplan.

### 1.2.5 Analytical Requirements and Additional Quality Assurance/Quality Control Samples

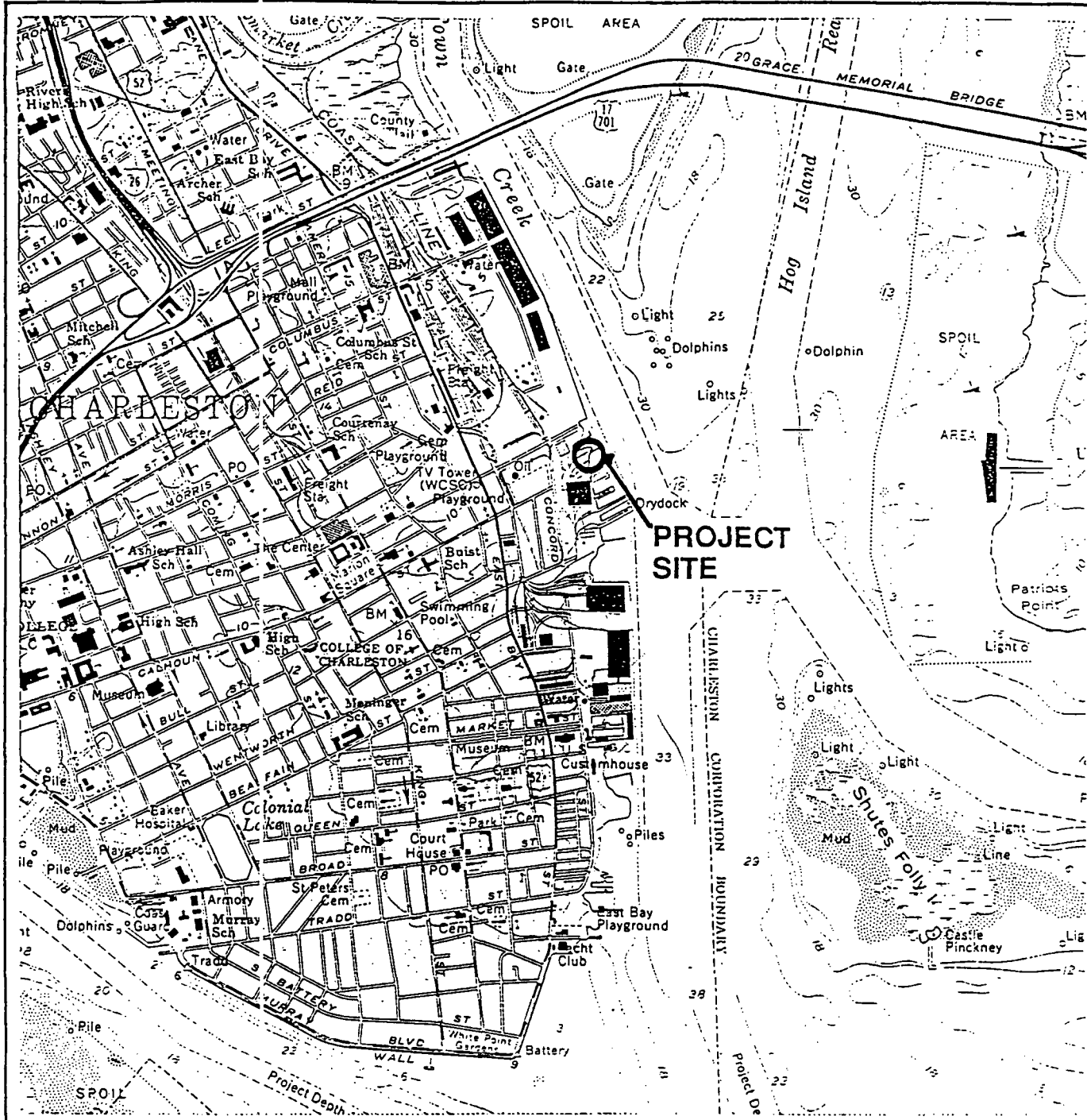
As required in the PSI Workplan, at least one sample from each soil boring and a minimum of twenty-five percent (25%) of all samples assigned for laboratory analysis were tested for the Target Analyte List/Target Compound List (TAL/TCL). The rest of the samples were tested for polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), benzene, toluene, ethylbenzene and xylenes (BTEX) and Priority Pollutant (PP) Metals. This analytical suite is also referred to as the Short List in this report. At least 10% of the shallow soil samples (including all Horizon A and Horizon B samples in the upland area and the top four feet in the intertidal area) were also submitted for dioxin testing, resulting in the analysis of 20 shallow samples for dioxin. One-half of these samples were analyzed for a full list of dioxin and dibenzofuran congeners, and the other half for 2,3,7,8-TCDD and -TCDF only. Additionally, 10 deep samples (Horizon C) were tested for a full list of dioxin and dibenzofuran congeners, as specified in the Workplan.

In accordance with the Workplan, two samples were assigned for laboratory analysis at each of the 20 sediment sampling locations. Ten of these samples were analyzed for TAL/TCL parameters, while the remaining 30 samples were analyzed for BTEX, PAH, PCBs, and PP Metals (the Short List). Four of the sediment samples were also analyzed for dioxin. Two of these samples were analyzed for a full list of dioxin and dibenzofuran congeners, and the other two for 2,3,7,8-TCDD and -TCDF.

As required by the agencies (in a letter dated January 19, 1994, included in Appendix A), 2 of the shallow soil samples and 1 deep soil sample were analyzed for dioxin using EPA SW-846 Method 8290, a high resolution GC/MS analytical method. Also, as required, all sediment samples were analyzed for dioxin by Method 8290. The remaining samples were analyzed for dioxin by Method 8280, as proposed.

Samples from the newly installed monitoring well (MW-KA1) and the two existing monitoring wells (MW-03 and MW-11) were analyzed for all TAL/TCL constituents, as was the surface water sample from Cooper River.

QA/QC samples consisting of equipment rinsate blanks, trip blanks, and duplicates were obtained as specified in the Quality Assurance/Quality Control Plan. In response to the requirements set forth by the regulatory agencies (in a letter dated January 19, 1994, included in Appendix A), additional QA/QC samples were obtained as follows. Two sets of equipment rinsate blanks were collected for every group of 20 samples, instead of 1 set. One set of equipment rinsate blanks represented the sample collection devices (split spoon/trowel/mixing bowl) and one set represented the drilling equipment (drilling bit, rods, etc.). Blank samples were also collected from the organic free water, tap water, drilling mud, bentonite grout, cement/bentonite grout, and sand pack. Additionally, Performance Evaluation samples (spiked samples brought to the site by the EPA) were analyzed for the parameters requested by the EPA.



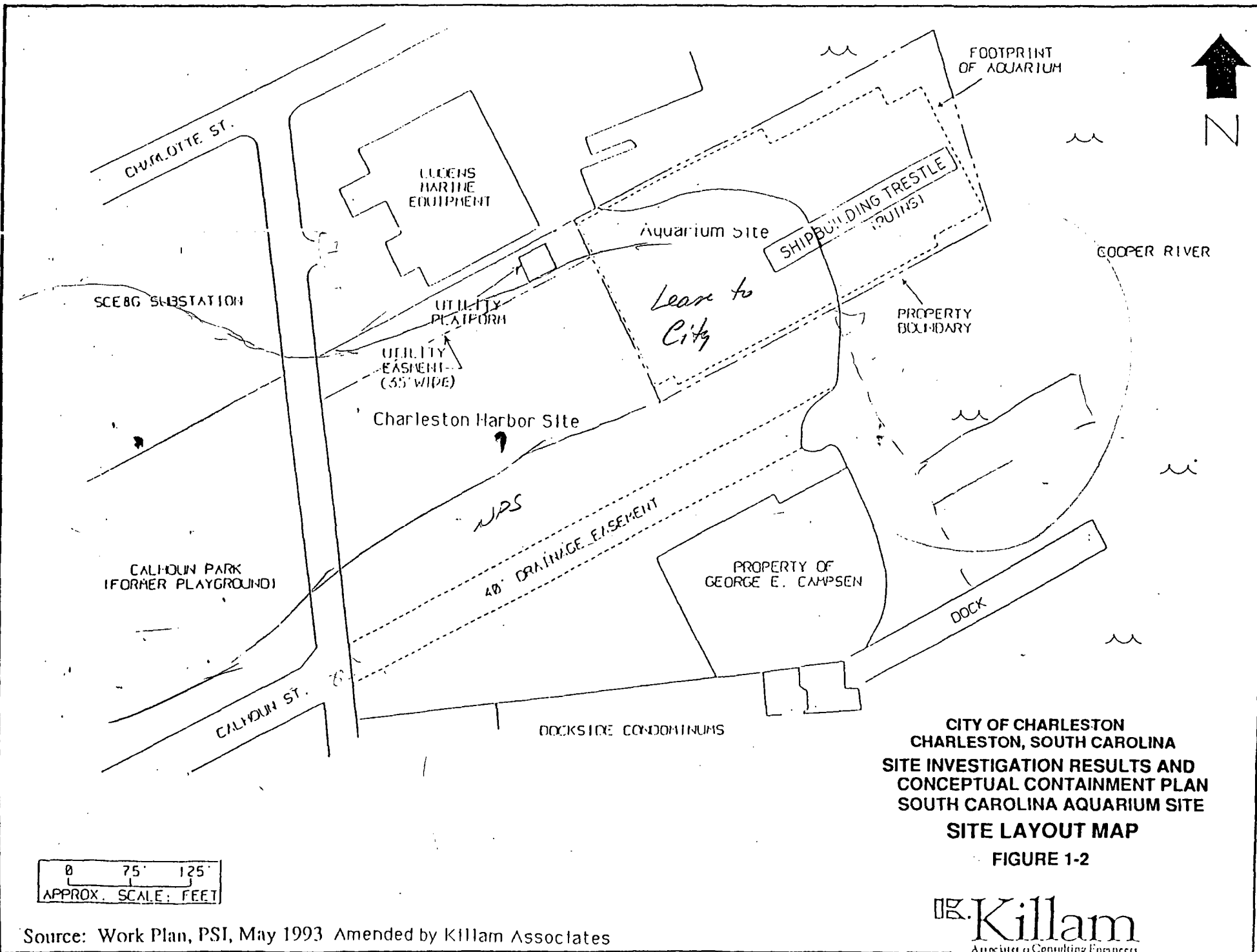
**CITY OF CHARLESTON  
CHARLESTON, SOUTH CAROLINA  
SITE INVESTIGATION RESULTS AND  
CONCEPTUAL CONTAINMENT PLAN  
SOUTH CAROLINA AQUARIUM SITE**

**SCALE: 1 INCH = 2,000 FEET**

**MAP SOURCE: USGS Charleston Quadrangle  
7.5 Minute Series  
Photorevised 1979**

**SITE LOCATION MAP  
FIGURE 1-1**

**Killam**  
Associates Consulting Engineers



Source: Work Plan, PSI, May 1993 Amended by Killam Associates

U . S . E P A R E G I O N I V

# SDMS

## Unscannable Material Target Sheet

DocID: 10092718 Site ID: SCD 987581337

Site Name: CALHOUN Park

### Nature of Material:

Map: ✓

Computer Disks:           

Photos: —

CD-ROM:           

Blueprints:           

Oversized Report:           

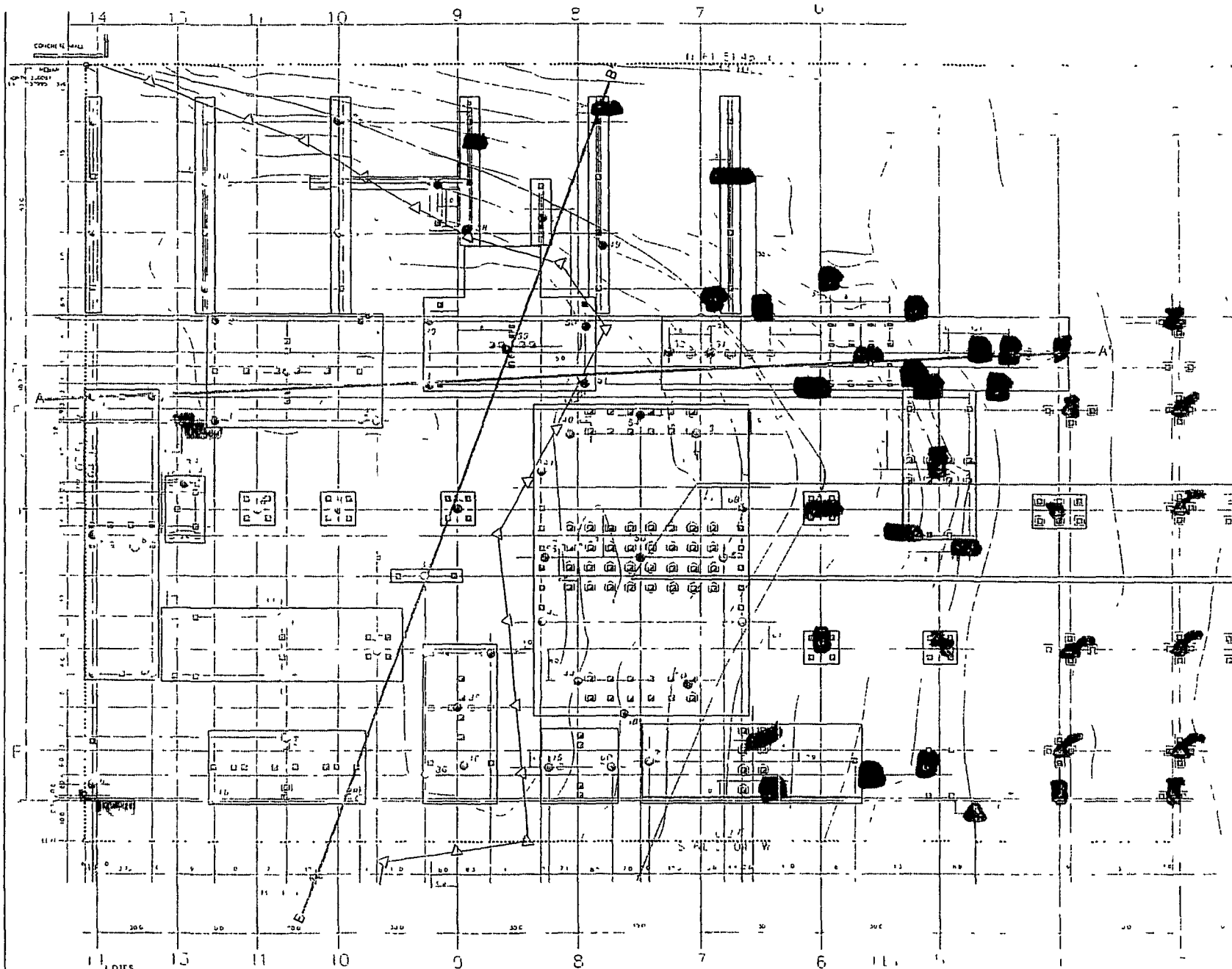
Slides:           

Log Book:           

Other (describe): Black & white Killam site maps

Amount of material: 2 maps

**\*Please contact the appropriate Records Center to view the material.\***



1. This map is based on information obtained from Sheet Nos. 1, 1 F-2, C-1, C-4 of Contract Drawing dated February 1, 1993 and the Sample Locality Map in the PSI Workplan dated May 1993 and modified September 1993.
2. Mean low tide is reported at -2.3 ft MSL. Mean high tide is reported at +2.9 ft MSL (U.S. Army Corp. of Engineers).
3. All dimensions are in feet unless otherwise specified.
4. Ground surface elevation contours are based on Sheet No. C-1 of Contract Drawings and a vertical survey performed by Southeastern Surveying Inc. (last revised May 6, 1994).
5. Spot boring locations and monitoring well locations were marked in field.

- REMAINS OF BANQUET PIER
- PROPERTY LINE
- - - CONTOUR LINE (DATUM MSL)
- MEAN HIGH WATER LEVEL
- ▲ SALT WATER CRITICAL LINE

- SPOT BORING LOCATION UPLAND
- 1/2" REBAR

- MONITOR WELL
- PNE DRIVEIN VERTICAL
- PNE DRIVEIN OR 1/2" REBAR
- PNE DRIVEIN OR 1/2" REBAR
- PNE DRIVEIN OR 1/2" REBAR
- PNE DRIVEIN OR 1/2" REBAR





B88

B89

B90

B91

90 ● SOIL BORING LOCATION

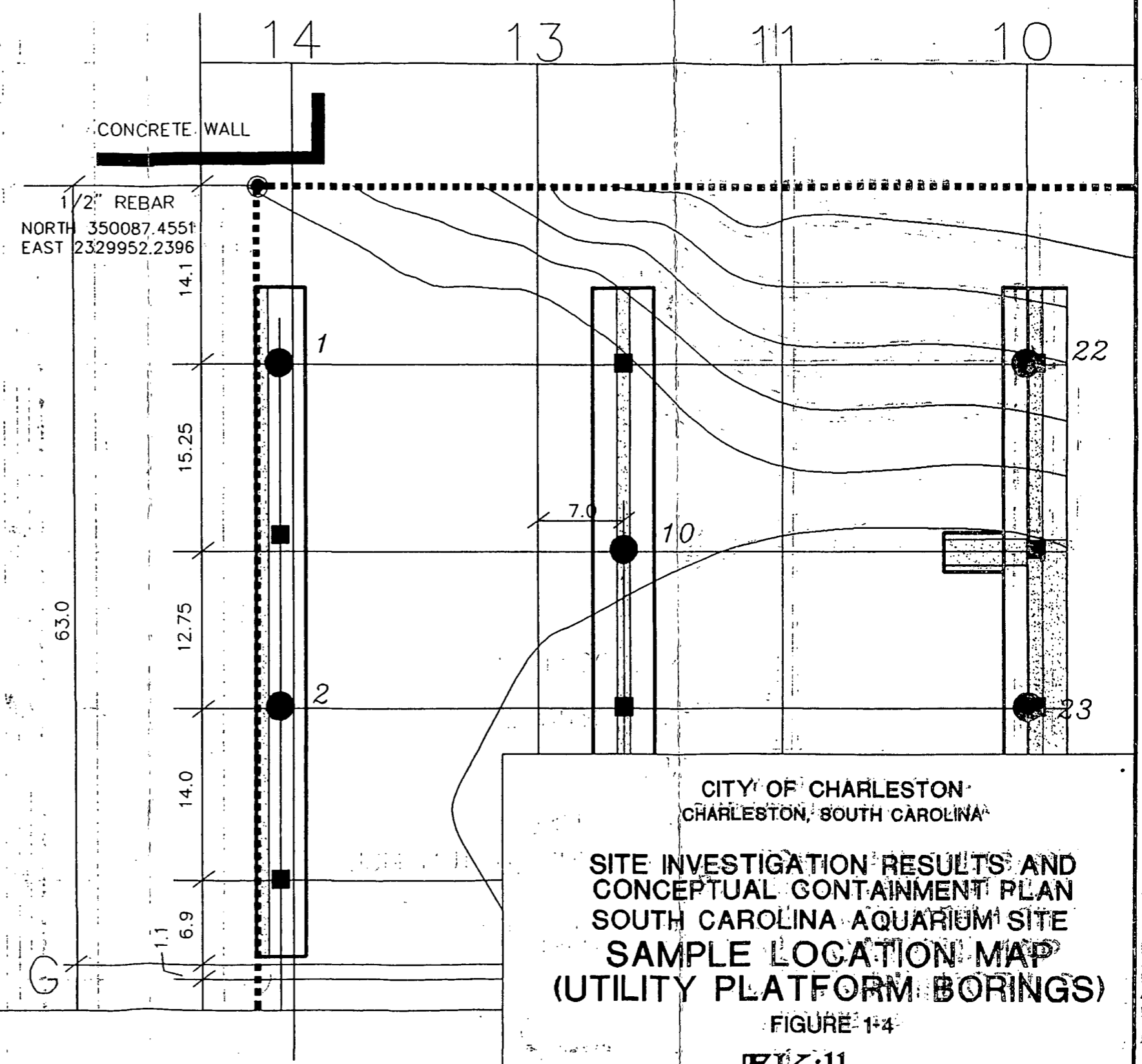
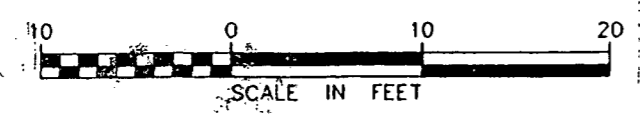
■ PILE DRIVEN VERTICAL

○ 1/2" REBAR

----- PROPERTY LINE

— 3 — CONTOUR LINE (DATUM MSL)

NOTE: A total of four utility platform borings were installed (B88, B89, B90, and B91).

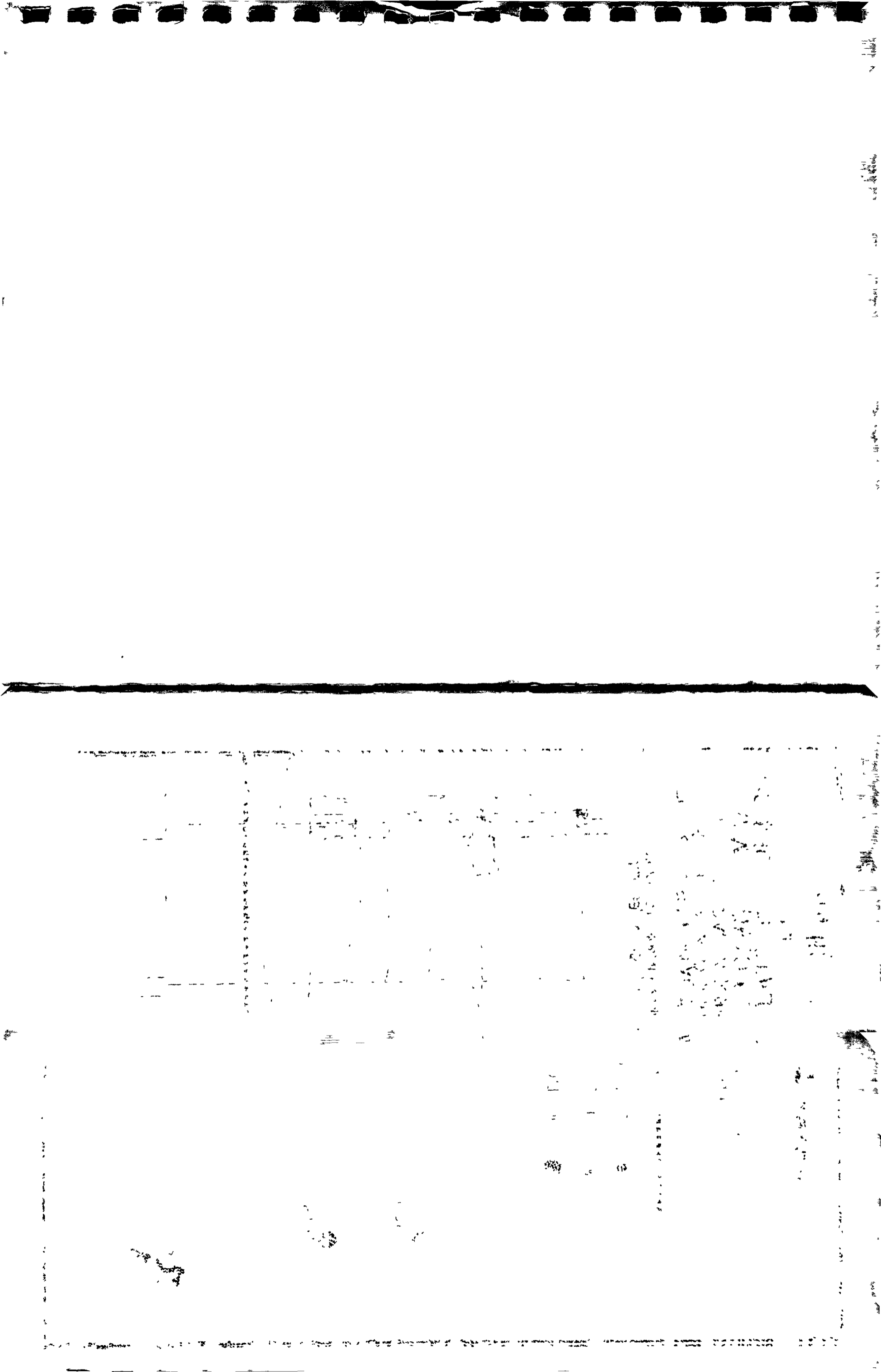


CITY OF CHARLESTON  
CHARLESTON, SOUTH CAROLINA

SITE INVESTIGATION RESULTS AND  
CONCEPTUAL CONTAINMENT PLAN  
SOUTH CAROLINA AQUARIUM SITE  
SAMPLE LOCATION MAP  
(UTILITY PLATFORM BORINGS)

FIGURE 1-4

**Killam**  
Associates a Consulting Engineers



U . S . E P A R E G I O N I V

# SDMS

## Unscannable Material Target Sheet

DocID: 10094676 Site ID: SCD987581332

Site Name: Cal Houn Park

### Nature of Material:

Map:

☒

Computer Disks:

☐

Photos:

☐

CD-ROM:

☐

Blueprints:

☐

Oversized Report:

☐

Slides:

☐

Log Book:

☐

Other (describe):

Killam map

Amount of material:

1 map

**\*Please contact the appropriate Records Center to view the material.\***

## **2.0 FIELD SAMPLING PROCEDURES AND OBSERVATIONS**

### **2.1 Site Preparation and Sample Location Markout**

Prior to the initiation of the field work, the City of Charleston removed the debris piles located above the ground surface on the upland portion of the site. Figure 1-3 indicates the ground surface elevation contours after the site clearing and regrading work was completed. Additionally, obstructions which would have interfered with the drilling work in the intertidal area (i.e. steel cable debris and portions of an abandoned pier) were removed prior to the initiation of work in this area.

The sample locations as indicated in the PSI Workplan (Figure 3 - Sample Location Map) were surveyed and staked in the field by Southeastern Surveying Inc. under the observation of Killam Associates. The boring locations were measured off from a benchmark (1/2 inch rebar) located on the western corner of the Aquarium Site tract (See Figure 1-3). The ground surface elevation at each upland and intertidal sample location was surveyed by Southeastern Surveying Inc., using a benchmark in the foundation of the building on the adjacent property (Luden's Marine). Sediment sampling locations within the Cooper River were temporarily marked by measuring off distances from surveyed guiding points along the shore. The actual locations of all sampling points, as installed, were measured off from the staked locations and are shown on Figure 1-3.

The following observations were made with respect to surface conditions in the upland and intertidal area. The remains of a pier (actually, a ship-building trestle) were evident in the central portion of the site. The structure consisted of creosote-treated timber beams and pilings. Additionally, the remains of what appears to be a former ship slipway was visible between grid lines B and C on Figure 1-3. The horizontal members of this structure are buried under fill on the upland portion of the site, but can be seen extending into the intertidal area. The timber supporting members of this structure are visible during low tide. In the southern portion of the site, the remains of what appear to be former railroad lines are evident. The tracks appear to run perpendicular to the shoreline in two to three locations. In the northern portion of the upland area (in the vicinity of boring locations B-39, B-40, B-47, B-49, B-50 through B-54 and B-61), near surface and subsurface debris consisting of metals, slag and concrete was evident.

The intertidal area was composed of a brick and belgian block rip-rap and miscellaneous solid debris. Various types of materials including slag, what appear to be steel plated gun turrets, steel cables, chunks of concrete and other miscellaneous debris were also evident on the surface in the intertidal area.

### **2.2 Soil Boring Installation in the Upland Area**

The drilling work commenced with the installation of soil borings in the upland portion of the site on January 31, 1994. A majority of the drilling work was performed with mud rotary drilling equipment. In a few locations, an air hammer drill rig and/or a track-hoe were utilized to penetrate through shallow debris which could not be penetrated with the mud rotary method.

Specific information regarding the drilling method used at each location is indicated on the boring logs (Appendix B).

Samples were collected using the procedures detailed in the Quality Assurance/Quality Control Plan, the Addendum to the Quality Assurance/Quality Control Plan and Health and Safety Plan/Contingency Plan (Appendix A), and agency comments transmitted in a letter dated January 19, 1994 (Appendix A).

On the third day of the drilling program, indications of floating hydrocarbon product were noted in the split spoon sample at a depth of 6 ft., at boring location B-36. Oil globules were also noted on the surface of the drilling mud in the mud pan. The product had a petroleum odor. Similar observations were made at boring location B-46. In response to these observations and a concern that hydrocarbon product may be circulated to deeper, uncontaminated strata, a modification of the drilling procedure was developed. The modified procedure consisted of the installation of steel casing to seal off the hydrocarbon-impacted zone. The modified procedure was followed at all locations where the presence of product/sheens in the split spoon sample, or the presence of product globules/sheens in the drilling mud were noted. At these locations, steel casing was installed to the depth of the fill material (typically 15 ft. to 25 ft.), the contaminated drilling mud was flushed from the drilling equipment and new drilling mud was mixed to complete the boring. This procedure was approved in the field by EPA and SCDHEC personnel, and documented in a letter dated February 28, 1994 (Appendix A).

Borings B-5, B-6, B-41, B-56, and B-68 had to be terminated at less than the required depth (ranging from 35 ft. to 57 ft.). Product globules/sheens were noted at these borings in either the drilling mud tub or in the split spoon sample, at depths of more than 30 ft. below surface. The casing at each of these locations could not be advanced to the required depth due to the presence of obstructions. The borings were therefore terminated to avoid cross-contamination of deeper strata. At B-6, B-41, B-56 and B-68, the hydrocarbon product and/or sheens and the refusal both appeared to be related to the presence of creosote-treated timber pilings at or very close to the boring location.

In all, 44 out of a total of 66 upland borings were cased due to the presence of sheens and/or hydrocarbon product. Specific information regarding the observed occurrence of hydrocarbon product and/or sheens in the upland soil borings is included in the boring logs and summarized in Table 2-1.

At boring B-58, the first drilling attempt at this location resulted in a noticeable drilling mud loss at a depth of about 17 ft. At the same time, drilling mud emerged from the ground approximately 10 ft. away from the boring, as well as in the river adjacent to the boring. The drilling mud appeared to be escaping along a buried horizontal timber, from the boring location to the river. The mud released to the river had a few oil droplets in it, which quickly dissipated into sheens. The area was immediately surrounded with 80 ft. of oil-absorbent boom, and the mud and sheens in the water were soaked up with absorbent material. The contaminated mud that appeared out of the ground was also removed with absorbent material, and the surficial soil

was scraped up and properly contained. All appropriate notification and response procedures outlined in the Health and Safety Plan/Contingency Plan were implemented. The incident was judged as requiring no further action by Mr. Rich Richter of SCDHEC. The boring was eventually installed by using a track-hoe to advance through the fill material. A similar incident occurred during the first drilling attempt at location B-39. Mr. Wayne Fanning of SCDHEC was present at the site during this incident, and was satisfied with the response procedures implemented. This boring was eventually installed using an air hammer drill rig to advance through the fill material. As a result of these two incidents, borings B-47, B-49, B-58, and B-69 (which are located at the edge of the intertidal area) were completed using a modified procedure, and after a containment system was in place, as described in the next section.

### 2.3 Soil Boring Installation in the Intertidal Area

During the installation of some of the upland borings, hydrocarbon product globules and/or sheens had been noted in the drilling mud, and in some instances, in the split spoon samples. These observations led to a concern regarding the possible release of these contaminants to the river during the drilling of borings in the intertidal area. Consequently, a modified drilling procedure was developed to minimize the risk of release of any sheens or other forms of hydrocarbon product, contaminated drilling fluids or sediments to the river.

The modified procedure was detailed in the Addendum document dated March, 1994 (Appendix A). In summary, the modified procedure included: 1) the excavation of surface and near-surface debris using a track-hoe; 2) sampling of the material excavated by the track-hoe, at 2 ft. intervals for the first 10 feet of excavated depth; 3) installation of a 6-inch casing into the underlying sediment, and placement of a bentonite seal at the bottom of the excavation; 4) backfill of the excavation with native material, or clean imported fill if the native material indicated significant sheens and/or product; 5) placement of another bentonite seal at the top of the excavation; 6) installation of the boring within the outer casing, using mud rotary drilling; and 7) installation of an inner casing to the depth of the affected zone, if hydrocarbon product and/or sheens were encountered.

This procedure was approved by NPS and the regulatory agencies, with the understanding that its effectiveness would be evaluated in the field during the installation of 1 to 2 trial borings. The agencies also recommended that the containment system to be installed for the duration of the field work, as proposed in the Addendum, be upgraded to contain any floating, suspended and/or settleable contaminants, from the sediment layer to the water surface (letter dated March 24, 1994 included in Appendix A). The agencies' recommendations were accepted, and a containment system composed of floating absorbent booms and a turbidity curtain were installed around the perimeter of the work area. The first 1 or 2 trial borings were installed, and, upon achieving acceptable results, all of the intertidal borings and four upland borings located very close to the water's edge were installed using this procedure. The only significant departure from the proposed procedure was the elimination of the concrete "sono-tube" collar around the outer casing, which was found to be unnecessary. Three of the intertidal borings (B-64, B-66, and B-84) were located in a permanently submerged (subtidal) location. These three borings

were installed within a 4-inch casing, using a barge mounted mud rotary drill rig, in accordance with the procedures outlined in the Addendum document.

Significant observations during the installation of the intertidal borings include the following. At the location of the three subtidal borings (B-64, B-66, and B-84), as well as some of the intertidal borings, stringers and/or pockets of a tar-like substance were noted in the split spoons at depths ranging from 6 ft. to 40 ft. The material was very viscous and had a petroleum odor. Specific observations regarding the occurrence of this material are included in the boring logs and are summarized in Table 2-1.

In contrast with the upland soil borings, hydrocarbon product globules floating in the drilling mud tub were not observed at the intertidal locations. However, the excavated fill material and the shallow split spoon samples, frequently had a sheen on the surface.

At three of the intertidal borings (B-74, B-78 and B-85), 35 to 40 ft. of inner casing was installed within the outer 6-inch casing. The inner casing was installed primarily due to the presence of the tar-like substance mentioned previously, at depths of up to 40 ft.

## 2.4 Sediment Sampling

Sediment samples were collected in twenty locations. The samples were collected manually using a 4 ft. long split spoon sampler attached to a 10 to 20 ft. length of drilling rod. A majority of the sediment samples indicated one or more of the following characteristics: a petroleum odor, sheens, and black staining. Hydrocarbon product globules were observed in sediment samples S02-1.5 and S08-03, collected at depths of 0.5-1.5 ft. and 2-3 ft., respectively. In general, the uppermost 6-inch layer of sediment appeared to be relatively free of contamination based on visual observations. This surficial layer of sediment was also distinguishable from the underlying sediments by its lighter color. Specific observations regarding the sediment samples are included in the boring logs (Appendix B) and summarized in Table 2-1.

The PSI Workplan required that two samples be collected at each location, "one at the river bottom, and one at 2 to 3 ft. below the river bottom". Consistent with this requirement, samples were to be collected at depths of 0-0.5 ft. and 2.5-3.0 ft. During the field sampling program, a concern was expressed by the on-site NPS representative that samples from these two discrete depths may not be representative of the worst case conditions. Consequently, at the request of the on-site NPS representative, samples of the two areas of sediment which appeared to be the most visibly contaminated between 0 to 3.5 ft., were collected for analysis from each 4 ft. split spoon sample. Actual sample depths therefore varied from the Workplan-specified sample intervals in some locations.

## 2.5 Groundwater and Surface Water Sampling

Three monitoring wells MW-KA1, MW-8 and MW-11 were sampled in accordance with the procedures detailed in the Quality Control/Quality Assurance Plan and agency comments transmitted in a letter dated January 19, 1994 (Appendix A). Data collected during well sampling includes the presence/absence of hydrocarbon product, depth to water before and after purging, depth to water before and after sampling, purge volumes, pH, dissolved oxygen, temperature, and specific conductivity. This information is summarized in the form of sampling logs, included in Appendix C. No hydrocarbon product was noted in any of the monitoring wells. The three monitoring wells were surveyed for elevation. This information is also included in the well sampling logs.

The 3 wells were sampled for TAL/TCL parameters. At the same time, a surface water sample was obtained from the Cooper River, and analyzed for TAL/TCL parameters.

SUMMARY OF HYDROCARBON PRODUCT/SHEENS OBSERVED  
DURING INSTALLATION OF SOIL BORINGS

TABLE 2-1

Boring Location	Casing Installed	Hydrocarbon Product in Split-Spoon	Sheen in Split-Spoon	Hydrocarbon Product in Mud Tub	Sheen in Mud Tub	Comments
B01	--	--	--	--	--	
B02	--	--	--	--	--	
B03	4" set @ 40'	--	--	Oil globules @ 2'-4'	Minor Sheen @ 2'-4' and 35'	Minor sheen and oil globules @ 2' to 4' likely associated with wood debris drilled through.
B04	--	--	--	--	--	Some wood @ 2' to 4'.
B05	--	--	--	Free product/wood fragments @ 47'	--	
B06	4" set @ 20'	Oil globules @ 2'-4'	--	Oil globules in mud pan @ 5' and 40'-42'	--	Drill through wooden timber which produced sheens on mud surface @ 40'-42'.
B07	3" set @ 25'	--	--	Oil globules @ 5'-6'	--	
B08	3" set @ 25'	--	--	--	Sheen in mud tub @ 20' (wood noted @ 20'-22' and 25'-27')	Hydraulic leak in drill rig prompts mud change
B09	4" set @ 30'	--	--	Oil globules @ 0'-2'	--	
B10	3" set @ 20'	--	--	Oil globules @ 12'-15'	--	
B11	--	--	--	--	--	
B12	--	--	--	--	--	Influx of wood fragments @ 2'-4'

SUMMARY OF HYDROCARBON PRODUCT/SHEENS OBSERVED  
DURING INSTALLATION OF SOIL BORINGS

TABLE 2-1

Boring Location	Casing Installed	Hydrocarbon Product in Split-Spoon	Sheen in Split-Spoon	Hydrocarbon Product in Mud Tub	Sheen in Mud Tub	Comments
B13	--	--	--	--	--	Black stained wood @ 2' in split-spoon.
B14	--	--	--	--	Slight sheen @ 50'-52'	
B15	4" set @ 25'	--	Sheen on wood fragment @ 0'-2'	Black oily sheen/free product @ 2'-4'	--	
B16	--	--	--	--	--	
B17	--	--	Wood with creosote/sheen @ 2'-4'	--	Wood fragments and creosote-like sheen @ 3'-5'	
B18	4" set @ 20'		Sheen @ 10'-12'	--	--	Wood @ 0.5', wood @ 5'-7' is creosote stained, wood with creosote odor in mud pan @ 18', wood timber @ 58'-59'.
B19	4" set @ 20'	--	Sheen @ 2'-4', 10'-12' and 20'-22'	--	Slight sheen and creosote floating material @ 4'	Wood fragments with black staining @ 2'-4'
B20	4" set @ 20'	Creosote saturated @ 2'-4'	--	Creosote like product @ 3'-4'	--	
B21	--	--	--	--	--	
B22	--	--	--	--	--	Wood fragments @ 35'
B23	--	--	--	--	--	Wood fragments with creosote staining @ 10'-12'

SUMMARY OF HYDROCARBON PRODUCT/SHEENS OBSERVED  
DURING INSTALLATION OF SOIL BORINGS

TABLE 2-1

Boring Location	Casing Installed	Hydrocarbon Product in Split-Spoon	Sheen in Split-Spoon	Hydrocarbon Product in Mud Tub	Sheen in Mud Tub	Comments
B24	--	--	--	--	Minor sheen on drilling mud @ 15'	
B25	4" set @ 20'	--	--	--	Wood fragments/oily sheen @ 10'-15'	
B26	--	--	--	--	--	Wood with creosote @ 3', Wood fragments with black staining @ 8'-10'.
B27	4" set @ 20'	--	--	Free product @ 5.0' (creosote)	--	
B28	--	--	--	--	--	
B29	3" set @ 20'	--	--	--	--	Creosote staining @ 3'-5'.
B30	--	--	--	--	Wood fragments/slight sheen @ 7'-9'	Sheen likely associated with wood.
B31	4" set @ 20'	--	--	--	Wood fragments, sheen @ 7'-9'	Sheens likely associated with wood.
B32	--	--	--	--	Sheen @ 5'-7'	
B33	4" set @ 20'	--	Sheen @ 2'-4' and 7'-9'	--	--	
B34	3" set @ 20'	Product @ 6'	--	--	--	

SUMMARY OF HYDROCARBON PRODUCT/SHEENS OBSERVED  
DURING INSTALLATION OF SOIL BORINGS

TABLE 2-1

Boring Location	Casing Installed	Hydrocarbon Product in Split-Spoon	Sheen in Split-Spoon	Hydrocarbon Product in Mud Tub	Sheen in Mud Tub	Comments
B35	3" set @ 15'	creosote @ 51'-53'	@ 8'-10'	Oil globules @ 2'-3'	--	
B36	4" set @ 30'	Oil globules @ 5'-7'	Sheen @ 10'-12'	@ 5'-7'	--	Wood debris in 0'-2', 2'-4' and 15'-17' intervals.
B37	6" set @ 12'	--	Sheen @ 2'-4'	--	--	
B38	3" set @ 20'	--	--	--	Wood/sheen 3'-5'	
B39	3" set @ 20'	Oil globules in cuttings @ 8'	--			Sheen on water collected during air rotary drilling.
B40	3" set @ 20'	--	@ 10'-12'	@ 5'-7'	--	Influx of free product @ 7.0' during air rotary drilling.
B41	4" set @ 24'	--	@ 2'-4' 8'-10' 18'-20' 40'-42'	Free product (creosote-like) @ 5' and @ 8'-10' Wood/free product/sheen @ 37'	--	Wood/sheen @ 2'-4' and 40'-42' split-spoon. Large quantities of wood @ 15'. Terminated @ 42'.
B42	3" set @ 25'					
B43	3" set @ 21'	--	@ 12'-14' 15'-17'	Oil globules @ 4'	--	

SUMMARY OF HYDROCARBON PRODUCT/SHEENS OBSERVED  
DURING INSTALLATION OF SOIL BORINGS

TABLE 2-1

Boring Location	Casing Installed	Hydrocarbon Product in Split-Spoon	Sheen in Split-Spoon	Hydrocarbon Product in Mud Tub	Sheen in Mud Tub	Comments
B44	3" set @ 20'	--	--	Oil globules @ 4'	--	
B45	3" set @ 15'	--	@ 10'-12'	Oil globules/sheen @ 5'-7'	--	Oil globule/sheen in mud tub @ 5'-7' associated with a wood fragment @ this split spoon interval
B46	4" set @ 20'	@ 5'-7'	@ 7'-17'	Oil globules @ 2'-4'	--	Wood fragment @ 12'-14'
B47	6" set @ 18'	--	--	--	--	Water surface of excavation exhibits a minor sheen. Creosote timbers in excavation.
B48	6" set @ 10.25'	--	--	--	--	Sample from excavation @ 2'-4' exhibits a sheen
B49	6" set @ 19'	--	--	--	--	
B50	3" set @ 20'	--	--	--	--	
B51	3" set @ 30'	Oil globules 4'-6'	@ 4'-6'	Few oil globules @ 25'-27'	--	
B52	3" set @ 20'	--	--	--	--	Wood @ 14'

SUMMARY OF HYDROCARBON PRODUCT/SHEENS OBSERVED  
DURING INSTALLATION OF SOIL BORINGS

TABLE 2-1

Boring Location	Casing Installed	Hydrocarbon Product in Split-Spoon	Sheen in Split-Spoon	Hydrocarbon Product in Mud Tub	Sheen in Mud Tub	Comments
B53	3" set @ 10.0'	--	--	--	--	
B54	3" set @ 10'	--	--	--	Slight sheen @ 2'	
B55	4" set @ 20'	--	--	Free product/sheen @ 5'		
B56	4" set @ 31'	Wood/sheen/ free product @ 33'-35'	--	Free product/sheen @ 33'		Terminated @ 35' due to a wooden piling encountered @ 31' - casing could not be advanced further
B57	4" set @ 27'	--	--	--	@ 6'-8' @ 18'-20'	
B58	6" set @ 19.5' 3" set @ 30'	--	--	--	@ 4'-5'	Sheen on water surface in excavation @ 3.5' Timber debris/creosote in excavation
B59	3" set @ 20'	--	--	--	@ 15'-17'	
B60	3" set @ 20'	--	Oily sheen @ 3.5'	--		

SUMMARY OF HYDROCARBON PRODUCT/SHEENS OBSERVED  
DURING INSTALLATION OF SOIL BORINGS

TABLE 2-1

Boring Location	Casing Installed	Hydrocarbon Product in Split-Spoon	Sheen in Split-Spoon	Hydrocarbon Product in Mud Tub	Sheen in Mud Tub	Comments
B61	3" set @ 25'	--	Sheen/staining @ 0'-1'	--	--	Casing set to control drilling fluid loss
B62	6" set @ 11'	--	@ 13'-25'	--	--	Sheen on sampler @ 0'-2' interval in excavation.
B63	6" set @ 17'	--	--	--	--	Water surface in excavation @ 5' has minor sheen. Oily fabric @ 8'-10'.
B64	4" set @ 40'	--	@ 4'-6'	--	@ 20'	Tar in samples @ 18'-31'.
B65	6" set @ 17'	--	--	--	--	Sheen on water surface of excavation @ 4'-6'.
B66	4" set @ 40'	Sheen/free product @ 35'-37'	Sheen/free product @ 35'-37'	--	@ 18'	Tar in samples @ 8'-32'.
B67	6" set @ 13'	--	Tar @ 13'-15'	--	--	Heavy sheen on water surface in excavation @ 0'-2'.
B68	4" set @ 37'	Free product/staining @ 20'-22'	25'-27', wood fragments w/sheen @ 40'-42'	Free product/sheen @ 19'-20' and @ 25'	Free product/sheen @ 19'-20' and @ 25'	Boring terminated @ 57' due to wooden piling @ 31' prohibiting advancement of casing.

SUMMARY OF HYDROCARBON PRODUCT/SHEENS OBSERVED  
DURING INSTALLATION OF SOIL BORINGS

TABLE 2-1

Boring Location	Casing Installed	Hydrocarbon Product in Split-Spoon	Sheen in Split-Spoon	Hydrocarbon Product in Mud Tub	Sheen in Mud Tub	Comments
B69	6" set @ 19'	--	Sheen/staining @ 5'-7'	--	--	
B70	4" set @ 20'	--	@ 5'-17'	Floating free product @ 17'	@ 4'	
B71	6" set @ 19'	--	@ 4'-6'	--	--	
B72	6" set @ 19'	Oily staining @ 11'-13'	@ 4'-6' @ 6-8'	--	@ 4'	Material in excavation exhibits sheen. Heavy sheen on water surface in excavation.
B73	6" set @ 11'	--	--	--	--	Water surface in excavation exhibits heavy sheen.
B74	6" set @ 13.5' 3" set @ 40'	--	Split-spoons from 13'-40'	--	--	Sheen on sample from excavation @ 2'-4'. Tar in split-spoons @ 23'-30'.
B75	6" set @ 19'	--	@ 4'-6' 19'-21'	--	--	
B76	6" set @ 19'	--	--	--	--	Water surface in excavation has floating free product.
B77	6" set @ 12.5'	--	--	--	--	Water surface in excavation has oily sheen. Sample from excavation @ 0'-2' has sheen.

SUMMARY OF HYDROCARBON PRODUCT/SHEENS OBSERVED  
DURING INSTALLATION OF SOIL BORINGS

TABLE 2-1

Boring Location	Casing Installed	Hydrocarbon Product in Split-Spoon	Sheen in Split-Spoon	Hydrocarbon Product in Mud Tub	Sheen in Mud Tub	Comments
B78	6" set @ 17.2' 4" set @ 36.5'	creosote @ 43'-45'	@ 4'-6'	@ 28'-33'	--	Water surface in excavation has minor sheen. The creosote is associated with wood fragments in the 43'-45' sample. Tar @ 4'-6'
B79	6" set @ 10'	--	--	--	--	Tar in split-spoons @ 13'-20' and 28'-30'.
B80	N/A					Surficial debris prevented installation of boring Minor sheens in excavation
B81	N/A					Sample from 2'-4' exhibited sheen. Sheen on water.
B82	N/A					Sample from 0'-2' exhibited sheen. Minor sheen on water.
B83	6" set @ 14'	--	tar/sheen @ 4'-6' and 14'-16'	--	--	Tar in split-spoons @ 4'-6', 14'-16', 23'-25', and 28'-30'
B84	4" set @ 40'	--	--	--	--	Tar in split-spoons @ 4' to 35'
B85	6" set @ 9.7' 3" set @ 25'	@ 13'-15'	@ 2'-4' 28'-30'	--	--	Water surface in excavation exhibits a sheen. Tar in split-spoons @ 13' to 25' and 38' to 40'
B86	N/A	--	--	--	--	Surficial debris prevented installation of boring. Water surface in excavation had heavy sheen.

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SUMMARY OF HYDROCARBON PRODUCT/SHEENS OBSERVED  
DURING INSTALLATION OF SOIL BORINGS

TABLE 2-1

Boring Location	Casing Installed	Hydrocarbon Product in Split-Spoon	Sheen in Split-Spoon	Hydrocarbon Product in Mud Tub	Sheen in Mud Tub	Comments
B87	6" set @ 10'	@ 8'-10'	@ 8'-25'	--	--	Tar in split-spoons @ 13' to 25'
B88	4" set @ 20'	--	@ 10'-12'	--	Slight sheen @ 10'	Wood fragments with creosote @ 6' Wood with creosote odor @ 10'
B89	--	--	--	--	Sheen @ 12'-15'	
B90	--	--	--	--	--	
B91	--	--	--	--	--	Creosote coated silt and wood fragments @ 10'-12'
S01	N/A	--	--	N/A	N/A	Shake test (2.0' to 3.0') produces immediate sheen
S02	N/A	Free product/ oil globules @ 1.5'	Sheen @ 1.5'-2.5'	N/A	N/A	Shake test produces immediate sheen/trace of black oil globules
S03	N/A	--	Sheen @ 1.0'-2.5'	N/A	N/A	
S04	N/A	--	--	N/A	N/A	
S05	N/A	--	--	N/A	N/A	
S06	N/A	--	--	N/A	N/A	Shake test (1'-2') produces immediate sheen
S07	N/A	--	Sheen 1'-2'	N/A	N/A	
S08	N/A	Free product/ oil globules @ 2'-2.5'	--	N/A	N/A	Shake test (1.5'-2') produces blue gray sheen. Wood fragments @ 1'.
S09	N/A	--	--	N/A	N/A	Shake test produces discernable sheen with creosote odor

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SUMMARY OF HYDROCARBON PRODUCT/SHEENS OBSERVED  
DURING INSTALLATION OF SOIL BORINGS

TABLE 2-1

Boring Location	Casing Installed	Hydrocarbon Product in Split-Spoon	Sheen in Split-Spoon	Hydrocarbon Product in Mud Tub	Sheen in Mud Tub	Comments
S10	N/A	--	--	N/A	N/A	
S11	N/A	--	@ 1.5'-4'	N/A	N/A	Shake test at 4' produces black oil globules
S12	N/A	--	Sheen @ 2.5'	N/A	N/A	
S13	N/A	--	Sheen @ 0'-2.5'	N/A	N/A	
S14	N/A	--	Slight sheen @ 2'-4'	N/A	N/A	Shake test produces slight sheen
S15	N/A	--	Sheen/wood fragments @ 0'-2'	N/A	N/A	
S16	N/A	--	Strong sheen @ 2.5'-4'	N/A	N/A	
S17	N/A	--	--	N/A	N/A	
S18	N/A	--	--	N/A	N/A	
S19	N/A	--	--	N/A	N/A	Shake test (2.5'-3.0') produces immediate sheen
S20	N/A	--	@ 0'-3'	N/A	N/A	

### 3.0 INVESTIGATION RESULTS

The analytical results of the investigation are discussed in this section. The discussion is structured according to the classification and format used in the PSI Workplan, i.e. Upland Soils (Horizon A, B and C), Intertidal Soils (Shallow and Deep), Sediments, Groundwater and Surface Water.

A complete listing of all samples obtained during this investigation is contained in a sample index included in Appendix D. Relevant information including sampling depths, sample collection and shipment dates, analyses performed, and sample delivery group (SDG) numbers are summarized in this index. The first 1 or 2 letters of the sample number indicate the media (B for soil samples, S for sediments, MW for groundwater and SW for surface water). The digits following these letters indicate the sample location number (boring number, sediment sampling location number, or monitoring well number). The number following the sampling location number, after a dash ('-'), indicates the depth of the sample. For example, B01-03 indicates a soil sample obtained from boring location B01, at a maximum depth of 3 ft. A duplicate of this sample would have the same designation except that the dash ('-') is replaced with the letter 'D', i.e. B01D03. Not all of the sediment samples could be identified using this convention. In some of the sediment sample numbers, the dash ('-') separating the location and the depth had to be omitted.

The analytical results for each sample are included in Appendix E. The results are arranged by sample location number and follow the listing in the sample index in Appendix D. Complete analytical data packages, including all supporting QA/QC information, are contained in Appendix F. The location of each sample result package within Appendix F is indicated on the sample index in Appendix D. Tabulated analytical results for the constituents of interest (defined below) are also summarized in Tables 3-2 through 3-8, and are arranged in the same format as the discussion below. Randomly pre-selected samples are indicated by an asterisk in these tables.

In order to direct the discussion to those contaminants which were found at meaningful levels, the data were first evaluated against screening levels to identify the constituents of concern. The screening levels were derived from a literature review of regulatory limits and/or potentially applicable criteria. Five potentially relevant sets of limits/criteria were reviewed. These included the following.

- Acceptable Risk Based Concentrations in residential soil as compiled by EPA Region III.
- The selected remedial goals at two Superfund manufactured gas plant (MGP) sites: Pine Street Canal Site in Burlington, Vermont, and People's Natural Gas Coal Gasification Site, Dubuque, Iowa.

- Draft marine sediment quality criteria established by EPA for five non-ionic organic chemicals (acenaphthene, fluoranthene, phenanthrene, Dieldrin, and endrin).
- Contaminant concentrations in marine and estuarine sediments which have been associated with adverse biological affects, defined as the Effects Range - Low (ERL) and the Effects Range - Median (ERM) by Long and MacDonald, 1993. (This is a follow-up study to the Long and Morgan document published in 1990 by NOAA as Technical Memorandum NOS OMA 52). The authors identified the lower 10th percentile concentration as the Effects Range - Low, and the 50th percentile concentration as the Effects Range - Median (ERM). Sediment contaminant concentrations below the ERL are said to be in the no-effect range, values between the ERL and ERM are in the possible effect range, and values above the ERM are in the probable effect range. The ERL was used in selecting an appropriate screening level.

These potentially relevant limits/criteria and the selected screening levels, along with the individual citations, are summarized in Table 3-1. The selected screening levels represent the most stringent value out of the six guidelines identified above, whether or not is was stictly appropriate to the medium being analyzed. (Note that the Long and MacDonald guidelines and the EPA draft sediment quality criteria are intended for sediments only.) This conservative approach was chosen to ensure that only the least relevant data were screened out from further review. It should be emphasized that the screening levels are not in any way intended to be perceived as action levels for any of the media at the Aquarium Site. They are simply a tool in reducing the volume of analytical data to be evaluated.

All available data were compared to the selected screening levels. Analytes which were found in excess of the screening levels in at least one sample were then identified as the constituents of concern. A total of 16 polynuclear aromatic hydrocarbons were identified as constituents of concern. These 16 PAHs include 7 carcinogenic PAHs. Although benzo(g,h,i)perylene was not found in excess of the screening level, it was included in the list of constituents of interest in order to accurately compare the Long and MacDonald Total PAH guidelines with the sum of the PAHs identified as constituents of concern. Also included on the list of constituents of concern are 13 metals, 2 base neutral compounds (2-methylnaphthalene and carbazole), 3 pesticides (Dieldrin, 4,4'-DDE, 4,4'-DDT), and 2 PCBs (Arochlor 1254 and Arochlor 1260).

The analytical data for the identified constituents of concern were divided into four categories. The four categories include:

- upland soils which will be excavated during construction to achieve the finished grade (i.e. soils above 3 ft. MSL, referred to as Horizon A soils in the PSI Workplan);

- upland soils which will be excavated during construction to allow for the installation of pile caps (referred to as Horizon B soils in the PSI Workplan);
- upland soils which will not be excavated, but will be preaugered (referred to as Horizon C soils);
- shallow intertidal soils which will be preaugered and may also be disturbed in limited areas where debris removal will be necessary to drive the piles;
- deeper intertidal soils which will only be preaugered; and,
- sediments of the Cooper River through which piles will be driven (without preaugering).

Tables summarizing these results are attached as Tables 3-2 through 3-8. These tables have been prepared as a guide to the discussion below. Complete results are included in Appendix E.

The NPS required the City of Charleston to document the worst case contamination potentially present at the Aquarium Site so that the NPS can properly assess the possible risk of significant releases of contaminants to the environment posed by the contemplated construction. Consistent with this objective, the data set primarily consists of biased samples. At each location, soil samples identified as being contaminated by field screening were substituted for some or all of the samples randomly preselected for laboratory analysis. This substitution of samples produced a set of data which is biased towards the maximum levels of contamination present at the site. Therefore, the average of reported contaminant concentrations should not be considered to represent or characterize the "average" concentration of contaminants within the site. This is particularly true for Horizon C soils, from which the highest percentage of biased samples was taken. For the purposes of this discussion, the "average reported" concentration of a given contaminant should be interpreted as a value which lies at an undefined position in a range which extends from the actual site average to the probable worst case.

To illustrate the bias which has been built into the present data set, the following statistical values were calculated for Horizon C soils. Of 148 soil samples, the "average reported" value for total PAH was 145 mg/kg. If this sample set is divided into pre-select (or random) samples and field-screened (or biased) samples, we find that the average total PAH concentration in the random subset is 12.6 mg/kg, while the comparable value for the biased subset is 255 mg/kg. Since the average concentration of the random samples better represents the quality of the "average" soil in Horizon C, the inclusion of the biased samples appears to distort the average concentration of PAH in the overall data set *by approximately one order of magnitude*.

An even greater contrast can be seen by comparing the arithmetic averages given above with median values for total PAH as follows: The median value of all samples is 0.67 mg/kg, while the median value of the preselect samples is 0.42 mg/kg.

This again reflects the influence of the biased samples on the overall data set. Since the data consist of two separate and distinct populations, utilization of these data to characterize the overall level of contamination at the site must involve separation of the data points into random and biased subsets in order for a subsequent evaluation of average site characteristics to be meaningful.

In the following discussion, the reported maximum concentration and the average concentration for each constituent of concern for Intertidal Soils and Sediments, is compared to the Long and MacDonald ERM. The total PAH concentration for each sample was summed by using a zero value for any non-detect result. The average reported concentration for total PAHs is, therefore, based upon the non-detect results being equivalent to zero. The average reported concentration for total CaPAHs and total PCBs was also calculated in the same manner. In contrast, the average reported concentration for individual metals and pesticides/PCBs was calculated using one-half of the sample quantitation limit for non-detect results. This was done to avoid under-representing contaminated samples with high detection limits and non-detect results.

### 3.1 Upland Soils

#### 3.1.1 Horizon A

A total of 53 samples (including duplicate samples) were collected in this horizon. Analytical results for BTEX and TAL/TCL (volatiles fraction) indicated that volatile organic contamination in this horizon is negligible. The highest levels of benzene, ethylbenzene and xylenes were found in sample B36-04 at levels of 1.8 µg/kg, 27 µg/kg and 64 µg/kg, respectively. The maximum concentration of toluene was detected in sample B56-02 at 2 µg/kg. Methyl ethyl ketone (MEK), also known as 2-butanone, was identified in some of the samples at trace concentrations. The TAL/TCL analysis did not reveal the presence of any other volatile organic contaminants except methylene chloride and acetone, which are common laboratory artifacts.

All targeted polynuclear aromatic hydrocarbons were detected in one or more of the samples. The data indicate that the highest concentration of total PAHs in this horizon (at 292 mg/kg) was detected in sample B56-02. The highest level of total carcinogenic PAHs (CaPAHs) was identified in sample B61-01 (at 107 mg/kg). The "average reported" concentration of total PAHs is 41 mg/kg. Other acid extractable/base neutral compounds detected include 2-methylnaphthalene, carbazole, dibenzofuran, phenol, bis(2-ethylhexyl) phthalate, 4-nitroaniline, di-n-butyl phthalate, butyl benzyl phthalate and diethyl phthalate. Some of these compounds, specifically the phthalates, are artifacts of typical laboratory sample handling/procedures (contact with gloves, plastic tubing, etc.).

Metals were detected in this horizon at widely varying levels. The highest concentrations of individual metals were detected in the following samples: sample B52-01 (antimony at 166 mg/kg and cadmium at 43.7 mg/kg); sample B53-01 (beryllium at 9.2 mg/kg, chromium at 571 mg/kg, lead at 43,600 mg/kg, nickel at 1510 mg/kg, silver at 4.6 mg/kg, vanadium at 13,000

mg/kg); B61-01 (arsenic at 130 mg/kg, copper at 11,600 mg/kg, manganese at 2,120 mg/kg, zinc at 8,640 mg/kg); and B42-03 (mercury at 10.5 mg/kg).

The pesticides dieldrin, 4,4'-DDE, and 4,4-DDT were detected at low concentrations in a number of the samples. The highest levels of the pesticides dieldrin, 4,4'-DDE and 4,4'-DDT were 5.2  $\mu\text{g/kg}$  (in B19-03), 230  $\mu\text{g/kg}$  (in B42-03), and 150  $\mu\text{g/kg}$  (in B52-01), respectively. Two PCBs (Arochlor 1254 and Arochlor 1260) were detected in a number of the samples. The highest concentration of total PCBs was detected in sample B58-01 at 12 mg/kg. The average reported concentration of total PCBs is 0.398 mg/kg.

2,3,7,8-TCDD was not detected in any samples from Horizon A. 2,3,7,8-TCDF was detected in samples B60-02, B60D02 and B47-02. The highest 2,3,7,8-TCDF value was reported in sample B60D02 at 0.425  $\mu\text{g/kg}$ .

### 3.1.2 Horizon B

A total of 27 samples (including duplicates) were obtained in this horizon. Analytical results for BTEX and TAL/TCL (volatiles fraction) indicated that volatile organic contamination in this horizon is not significant. The highest levels of benzene and toluene were found in samples B19-09 and B36-08, at 0.86  $\mu\text{g/kg}$  and 1.6  $\mu\text{g/kg}$ , respectively. The highest levels of ethylbenzene and xylenes were found in sample B70-07 at levels of 9  $\mu\text{g/kg}$  and 10  $\mu\text{g/kg}$ , respectively. MEK was identified in some samples at trace concentrations. Methylene chloride, carbon disulfide and acetone, which are common laboratory artifacts, were also revealed in the TAL/TCL analysis.

All targeted PAHs were detected in one or more of the samples. The data indicate that the highest concentration of total PAHs in this horizon (at 239 mg/kg) was detected in sample B70-07. The highest level of carcinogenic PAHs was also identified in sample B70-07 (at 89.3 mg/kg). The "average reported" concentration of total PAHs was 38.1 mg/kg. Other acid extractable/base neutral compounds detected include 2-methylnaphthalene, carbazole, dibenzofuran, di-n-butyl phthalate and bis(2-ethylhexyl) phthalate.

Metals were detected in this horizon at widely varying levels. The highest concentrations of individual metals were detected in the following samples: sample B22-02 (arsenic at 85.5 mg/kg); B46-07 (vanadium at 261 mg/kg); B53-08 (antimony at 169 mg/kg, cadmium at 5.8 mg/kg, chromium at 212 mg/kg, lead at 2,960 mg/kg, zinc at 8,880 mg/kg); sample B56-08 (mercury at 13.5 mg/kg); B60-05 (copper at 1,000 mg/kg); B69-02 (beryllium at 2.7 mg/kg, nickel at 224 mg/kg); and B70-07 (manganese at 463 mg/kg). Silver was not detected in any of the samples.

The pesticides dieldrin, 4,4'-DDE, and 4,4-DDT were detected at low concentrations in some of the samples. The highest levels of these pesticides were 4.5  $\mu\text{g/kg}$  (sample B56-08), 24  $\mu\text{g/kg}$  (sample B56-08), and 10  $\mu\text{g/kg}$  (sample B46-07), respectively. Two PCBs (Arochlor 1254 and Arochlor 1260) were detected in some of the samples. The highest concentration of

total PCBs was detected in sample B53-08 (at 8.90 mg/kg). The "average reported" concentration of total PCBs is 0.597 mg/kg.

2,3,7,8-TCDD and 2,3,7,8-TCDF were reported in sample B34-08 at 0.24 nanograms/kilogram (ng/kg) and 7.8, respectively. No additional samples in Horizon B were reported to contain 2,3,7,8-TCDD or 2,3,7,8-TCDF.

### 3.1.3 Horizon C

A total of 149 samples (including duplicates) were obtained in this horizon. The samples obtained in this horizon ranged in depth from 10 ft. to 80 ft. below grade. It should be noted that the C Horizon had the greatest percentage of samples (approximately 55%) that were selected for analysis on the basis of field screening. Thus, this horizon has the highest percentage of biased samples, which is consistent with the high results obtained for this horizon.

Analytical results for BTEX and TAL/TCL (volatiles fraction) indicated that by far the highest levels of benzene, toluene, ethylbenzene and xylene were found in sample B51-27 at levels of 4,300  $\mu\text{g/kg}$ , 15,000  $\mu\text{g/kg}$ , 2,400  $\mu\text{g/kg}$ , and 46,000  $\mu\text{g/kg}$ , respectively. However, in most of the samples these compounds were present at low concentrations or were not detected. The TAL/TCL analysis also revealed the presence of MEK, carbon disulfide and styrene at trace concentrations in some of the samples, and the presence of methylene chloride and acetone, which are common laboratory artifacts.

All targeted PAHs were detected in one or more of the samples. The highest concentration of total PAHs in this horizon (at 7,580 mg/kg) was detected in sample B91-12. The highest level of carcinogenic PAHs was also identified in sample B91-12 (at 1,920 mg/kg). The average reported concentration of total PAHs is 145 mg/kg. It is significant to note that 67 out of the 148 samples in Horizon C analyzed for PAH were unbiased randomly preselected samples. The average reported total PAH concentration in the unbiased data set is only 8.7% (12.6 mg/kg) of the "average reported" total PAH concentration for the entire data set for Horizon C. Other acid extractable/base neutral compounds detected include 2-methylnaphthalene, carbazole, dibenzofuran, di-n-butyl phthalate, bis(2-ethylhexyl) phthalate, 2-methylphenol, 4-methylphenol, 2-4-dimethylphenol and phenol.

Metals were detected in this horizon at widely varying levels. The highest concentrations of individual metals were detected in the following samples: sample B49-04 (antimony at 57.8 mg/kg, cadmium at 8.3 mg/kg, copper at 1,420 mg/kg, lead at 1,670 mg/kg, manganese at 864 mg/kg, nickel at 330 mg/kg, silver at 11.2 mg/kg, vanadium at 355 mg/kg, zinc at 6,410 mg/kg); sample B52-05 (arsenic at 50.9 mg/kg); sample B59-01 (mercury at 2.4 mg/kg); and, sample B44-67 (beryllium at 2 mg/kg).

The pesticides dieldrin, 4,4'-DDE, and 4,4-DDT were detected at low concentrations in some of the samples. The highest levels of these pesticides were 28  $\mu\text{g/kg}$  (sample B91-12), 210  $\mu\text{g/kg}$  (sample B51-27), and 5.7  $\mu\text{g/kg}$  (sample B58-25), respectively. Two PCBs (Arochlor

1254 and Arochlor 1260) were detected in some of the samples. The highest concentration of total PCBs was detected in sample B52-05 (at 210 mg/kg). The "average reported" concentration of total PCBs was 1.44 mg/kg.

2,3,7,8-TCDD and 2,3,7,8-TCDF were identified in sample B34D22 at 0.33 ng/kg and 0.37 ng/kg, respectively. They were not noted in any other sample from Horizon C.

In Horizon C, a total of 102 samples were collected from a depth greater than 22 feet (i.e. below the surficial fill). Of these 102 samples, 25 samples collected from 20 borings showed significant levels of PAH (i.e. total PAHs in excess of the screening level of 4.00 mg/kg). The locations and visual descriptions of these samples were examined to investigate the source of the PAH contamination at depth.

The borings from which these 25 samples were collected are: B-6, B-16, B-17, B-20, B-21, B-28, B-35, B-41, B-43, B-51, B-55, B-56, B-58, B-59, B-68, B-69, B-70, B-89, B-90, and B-91. Most of these samples were described as exhibiting one or more of the following characteristics: petroleum/creosote odor, possible staining, elevated HNu readings, visual indication of hydrocarbon product, and in some cases the presence of creosoted wood fragments. In at least five of these borings (B-06, B-41, B-55, B-56, B-68), the samples clearly showed evidence of creosoted timber pilings (Borings B-41, B-55, B-56 and B-68 were located in close proximity to the remains of a shipbuilding trestle built from creosoted timbers). The visual description of the other samples do not explicitly note the presence of wood fragments; however, the locations of these samples suggest that the presence of PAHs at depth may, at least partially, be attributable to creosote-treated timber pilings. With the exception of the utility platform borings (B-89, B-90, B-91), and the borings B-17 and B-51, these borings are all located in the southern portion of the site. Remnants of another structure built of creosoted timbers are evident in this area. A 1954 site plan of the U.S. Naval Industrial Reserve Shipyard existing on the site at that time shows the presence of a building ways and two trestles, with rail lines leading to them, in the area of the Aquarium footprint. Sampling results from borings B-17 and B-51 may also be related to creosote-treated timber pilings, as remnants of a former structure (wooden railroad ties) are evident on the surface in this area as well. One of the utility platform borings (B-91) indicated timber fragments at a shallow depth. There was no other obvious source of PAHs at depth in this area.

## 3.2 Intertidal Soils

### 3.2.1 Intertidal Shallow Soils

A total of 38 shallow soil samples (including duplicates) were collected from depths of 0 to 10 ft. (at 2 ft. intervals) at each intertidal sampling location. Analytical results for BTEX and TAL/TCL (volatiles fraction) indicated that volatile organic contamination in this horizon is not significant. The highest levels of benzene, toluene, ethylbenzene and xylene were identified at 3,200 µg/kg, 1,400 µg/kg, 2,800 µg/kg and 7,000 µg/kg, respectively. These levels were detected in sample B84-06. The TAL/TCL analysis also revealed the presence of carbon

disulfide and MEK. Additionally, the common laboratory contaminants methylene chloride and acetone were identified in some of the samples.

All targeted PAHs were detected in one or more of the samples. The highest concentration of total PAHs in these soils (at 9,518 mg/kg) was detected in sample B87-10. The highest level of total CaPAHs (at 1,458 mg/kg) was also found in sample B87-10. The "average reported" concentration of total PAHs (at 450 mg/kg) is one order of magnitude greater than the ERM of 44.8 mg/kg. Other acid extractable/base neutral compounds detected include 2-methylnaphthalene, carbazole, dibenzofuran, di-n-butyl phthalate, n-nitrosodiphenylamine, and bis(2-ethylhexyl) phthalate.

Metals were detected in these soils at widely varying levels. The highest concentrations of individual metals were detected in the following samples: sample B63-10 (antimony at 108 mg/kg, lead at 10,500 mg/kg, silver at 6.8 mg/kg); sample B48-04 (arsenic at 125 mg/kg, chromium at 8,020 mg/kg, zinc at 11,600 mg/kg); sample B76-02 (cadmium at 15 mg/kg, manganese at 2,650 mg/kg, mercury at 29.1 mg/kg); sample B74-04 (nickel at 559 mg/kg, vanadium at 5,380 mg/kg); sample B65-02 (beryllium at 10.9 mg/kg); and sample B65-04 (copper at 75,100 mg/kg). The "average reported" concentration of copper, lead, mercury, nickel and zinc exceed the ERM for these constituents. The "average reported" concentrations for the remaining metals are below the ERM.

The pesticides dieldrin 4,4'-DDE, and 4,4'-DDT, were detected at low levels in some of the shallow intertidal samples. The highest levels of dieldrin, 4,4'-DDE and 4,4'-DDT were detected in samples B72-04 at 17 µg/kg, B76-02 at 37 µg/kg and B72-04 at 9.10 µg/kg, respectively. The highest concentrations of total PCBs (Arochlor 1254 and Arochlor 1260) was detected in sample B78-02 at 23 mg/kg. The "average reported" concentration for total PCBs is 1.77 mg/kg, exceeding the ERM by a factor of ten.

2,3,7,8-TCDD was not detected in any intertidal shallow soil sample. 2,3,7,8-TCDF was detected in sample B82-02 at 0.959 µg/kg. No other samples from the shallow intertidal soils indicated a positive identification of either of these contaminants.

### 3.2.3 Intertidal Deep Soils

Forty eight (48) samples (including duplicates) were collected from intertidal soils at depths ranging from 10 ft. to 75 ft. Analytical results for BTEX and TAL/TCL (volatile fraction) indicated that the highest levels of benzene, toluene, ethylbenzene and xylene were 14,000 µg/kg (sample B66-32), 10,000 µg/kg (sample B66-32), 7,500 µg/kg (sample B83-25), and 25,000 µg/kg (sample B66-32), respectively. Acetone and methylene chloride, common laboratory artifacts, and carbon disulfide were identified in the TAL/TCL analysis.

All targeted PAHs were detected in one or more of the intertidal deep soils samples. The highest concentration of total PAHs in these soils was noted in sample B83-25 at 12,703 mg/kg. The highest level of CaPAHs was identified in sample B79-30 at 1,976 mg/kg. The "average

reported" concentration of total PAHs (is 1,855 mg/kg). Other acid extractable/base neutral compounds detected include 2,4-dimethylphenol, dibenzofuran, carbazole, 2-methylnaphthalene and nitrobenzene.

Metals were detected in these soils at widely varying concentrations. The highest concentrations of individual metals were identified in the following samples: sample B83-16 (antimony at 21.7 mg/kg, chromium at 124 mg/kg), sample B71-21 (arsenic at 43.8 mg/kg, mercury at 1.2 mg/kg), sample B74-30 (copper at 273 mg/kg, zinc at 1,980 mg/kg), sample B67-15 (manganese at 821 mg/kg, vanadium at 104 mg/kg), sample B79D20 (beryllium at 1.9 mg/kg), sample B84-15 (lead at 519 mg/kg), sample B65-12 (nickel at 43.3 mg/kg). Cadmium and silver were not detected in any of the intertidal deep soils samples.

The pesticides dieldrin, 4,4'-DDE and 4,4'-DDT were detected at low concentrations in some of the samples. The highest levels of these pesticides were: 22 µg/kg in sample B78-30; 92 µg/kg in sample B78-30; and, 21 µg/kg in sample B74-30, respectively. Arochlor 1254 and Arochlor 1260 were detected in some of the intertidal deep soils samples. The highest concentration of total PCBs was detected in sample B65-12 at 7.50 mg/kg. The "average reported" concentration of total PCBs was 157 µg/kg.

Neither 2,3,7,8-TCDD nor 2,3,7,8-TCDF were detected in any samples collected from the intertidal deep soils.

### 3.3 Sediments

Forty-one (41) samples (including a duplicate sample), representing the most visibly contaminated sections of each boring, were collected for analysis. Analytical results for the BTEX and TAL/TCL volatiles fraction indicated that volatile organic contamination is not significant in the sediments. The highest levels of benzene, toluene, ethylbenzene and xylenes were identified in sample S15-03 (benzene at 7.7 µg/kg), and sample S02-1.5 (toluene at 15 µg/kg, ethylbenzene at 2,000 µg/kg and xylene at 780 µg/kg). Methylene chloride, acetone and MEK were also detected in the TAL/TCL analysis.

All targeted PAHs were detected in one or more of the samples obtained from the sediments. Results indicate that the highest concentration of total PAHs was detected in sample S08-03 at 1,187 mg/kg. The highest level of total CaPAHs was also noted in sample S08-03 at 451 mg/kg. The average reported concentration of total PAHs at 130 mg/kg is three times in excess of the ERM of 44.8 mg/kg. Other acid extractable/base neutral compounds detected included 2-methylnaphthalene, carbazole, dibenzofuran, n-nitrosophenylamine, butylbenzyl phthalate, bis(2-ethylhexyl) phthalate, and nitrobenzene.

Metals were detected in the sediments at varying levels. The highest concentrations of individual metals were detected in the following samples: sample S19-0.5 (antimony at 9.1 mg/kg); sample S03-03 (arsenic at 46.6 mg/kg); sample S01-03 (beryllium at 1.8 mg/kg); sample S17-0.5 (cadmium at 1.5 mg/kg, lead at 283 mg/kg); sample S20-0.5 (chromium at 81 mg/kg); sample

S15-03 (copper at 204 mg/kg); sample S01-03 (manganese at 729 mg/kg); sample S02-1.5 (mercury at 20.5 mg/kg); sample S11-2.5 (nickel at 37.5 mg/kg); sample S19-03 (vanadium at 92.4 mg/kg); and, sample S17-0.5 (zinc at 685 mg/kg). Silver was not detected in any of the sediment samples. The "average reported" concentration of mercury was greater than the ERM. The "average reported" concentrations of the rest of the metals were below the ERMs.

The pesticides dieldrin, 4,4'-DDE and 4,4'-DDT were detected in one or more of the sediment samples. The highest levels of these pesticides were identified in sample S18-1.5 (Dieldrin at 18 µg/kg), sample S0-21.5 (4,4'-DDE at 35 µg/kg) and sample S14-03 (4,4'-DDT at 15 µg/kg). Two PCBs, Arochlor 1254 and Arochlor 1260, were detected at varying levels in the sediment samples. The highest concentration of total PCBs was detected in sample S07-01 at 410 µg/kg. The "average reported" concentration of total PCBs was 22 µg/kg, which is less than the ERM of 180 µg/kg. The "average reported" concentration for pesticides was below the ERM.

2,3,7,8-TCDD and 2,3,7,8-TCDF were detected in samples S0-40.5, S15-03, S17-0.5 and S17-03. The highest levels of 2,3,7,8-TCDD and 2,3,7,8-TCDF were detected in sample S17-0.5 at 4.3 ng/kg and 8 ng/kg, respectively.

### 3.4 Groundwater and Surface Water

Low levels of PAHs were identified in samples from the two shallow wells MW-8 and MW-11. total PAHs were identified at 193 µg/L and 540 µg/L in these wells, respectively. By comparison, the EPA acute Lowest Observed Effect Level (LOEL) for total PAHs is 300 µg/L (Salt Water Ambient Quality Criteria). Groundwater in the deeper well MW-KA1 indicated 5 µg/L of total PAHs. Trace concentrations of volatiles (benzene, toluene, ethylbenzene, xylenes, methylene chloride, and carbon disulfide) were also detected in the three monitoring wells. Additionally, low levels of the metals antimony, arsenic, beryllium, chromium, copper, lead, manganese, mercury, vanadium and zinc were identified. No pesticides or PCBs were detected.

The surface water sample did not indicate any volatiles (except the laboratory artifact methylene chloride), PAHs, pesticides or PCBs. The metals arsenic, lead, manganese, vanadium, and zinc were reported at trace concentrations.

### 3.5 QA/QC samples

#### 3.5.1 Trip Blanks

In accordance with the Quality Assurance/Quality Control Plan, trip blanks were collected to determine if any on-site atmospheric contaminants were seeping into the sample vials, or if any contamination of samples was occurring during shipment or storage of sample containers.

A total of 43 trip blanks were analyzed at a frequency of 1 per sample shipment, (with the exception of May 2, 1994, when one trip blank was inadvertently left out of the sampling container). The trip blank consisted of analyte-free water (certified by the laboratory) sealed in

a 40 ml Teflon lined septum vial and was supplied by the laboratory. Each trip blank was analyzed for Volatile Organics (3-90 CLP Statement of Work). Methylene chloride and acetone, which are common laboratory artifacts, were the only compounds identified in the trip blank analytical results.

### 3.5.2 Equipment Rinsate Blanks

Equipment rinsate blanks were collected to document that the pre-cleaned sampling equipment did not introduce contaminants into the samples. Equipment rinsate blanks consisted of analyte-free water, and were obtained by passing analyte-free water through or over decontaminated sampling devices (i.e. drilling rods, split spoons, PVC bailer, mixing bowls, etc.) For soil samples, 2 sets of equipment rinsate blanks were collected. One set represented the drilling equipment and the other set represented the sample collection equipment set. The letters "R" and "SP", which are the first letter(s) for these sample numbers, identifies the blank as being obtained from the drilling equipment set (rod) or the sample collection (split spoon) equipment set, respectively.

A total of 46 equipment rinsate blanks were collected at a frequency of approximately one per twenty for each analysis performed and each equipment set used. Six drilling rod equipment set rinsate blanks were analyzed for TAL/TCL; 10 for Short List; 1 for dioxin and dibenzofuran (all congeners) using Method 8290; 1 for 2,3,7,8-TCDD and -TCDF using Method 8280; 1 for dioxin and dibenzofuran (all congeners) using Method 8280; 1 for PAHs; and 1 for PCBs. For the split spoon equipment set rinsate blanks, the analyses breakdown is the following: 6 blanks for TAL/TCL; 11 blanks for Short List; 1 blank for dioxin and dibenzofuran (all congeners) using Method 8290; 1 blank for 2,3,7,8-TCDD and -TCDF using Method 8280; 2 blanks for 2,3,7,8-TCDD and -TCDF using Method 8290; 1 blank for dioxin and dibenzofuran (all congeners) using Method 8280; 1 blank for PAHs; and, 2 blanks for PCBs. Note that both the blanks which were sent for PCB and PAH analyses only were replacements for blank samples for which internal laboratory QA/QC criteria were not met.

Results for the equipment rinsate blanks indicated the presence of laboratory artifacts methylene chloride and acetone. Other target analytes were also identified as being present in these blanks at low concentrations.

### 3.5.3 Duplicates

Environmental duplicate samples were collected to demonstrate the reproducibility of the sampling technique. A total of 22 duplicate samples were collected. Seven duplicate samples were analyzed for TAL/TCL; eleven samples for Short List; one for 2,3,7,8-TCDD and -TCDF using Method 8290; one for 2,3,7,8-TCDD and -TCDF using Method 8280; one for dioxin and dibenzofuran (all congeners) using Method 8290; and one for dioxin and dibenzofuran (all congeners) using Method 8280.

The following samples were taken in duplicate: B04-47, B05-52, B07-03, B11-52, B14-03, B17-03, B24-03, B26-40, B28-57, B31-82, B34-22, B40-75, B48-70, B57-80, B60-02, B65-25, B67-40, B70-37, B74-35, B79-20, S08-03, and MW-KA1. With the exception of samples B28-57 and S08-03, these samples and their duplicates revealed similar results. The variation in sampling results between the sample and its duplicate for B28-57 and S08-03 was attributed by the laboratory to sample inhomogeneity.

#### **3.5.4 Field Blanks**

Field blanks were collected to determine the presence of contamination during sample collection and handling. These blanks consisted of: organic free water; tap water; drilling mud; cement-bentonite grout; sand; and bentonite grout. These blanks were all analyzed for TAL/TCL parameters. Methylene chloride and acetone, which are laboratory artifacts, were present in all of the field blank samples. Some target analytes (metals, volatile organics and semi-volatile organics) were detected at low concentrations in all field blanks with the exception of the organic free water blank. The drilling mud blank was taken directly from the mud tub. The mud tub was steam-cleaned and the mud circulation system was flushed prior to collecting the sample. However, due to the fact that it is not possible to completely decontaminate the entire mud circulation system, traces of residual PAH contamination were evident in the drilling mud blank sampling results. No pesticides or PCBs were detected in any of these samples.

#### **3.5.5 Performance Evaluation Samples**

USEPA provided Performance Evaluation Samples (PES) to assess quality control/quality assurance in the laboratory. Samples B91-62, B91-70, B99-32 and B99-33 were the EPA PES which were sent to the laboratory. Sample B91-62 was analyzed for TAL/TCL Semi-volatiles fraction only. Sample B91-70 was analyzed for TAL/TCL volatile organics, semi-volatiles and metals fractions. Sample B99-32 was analyzed for TAL/TCL, and sample B99-33 was analyzed for TAL/TCL semi-volatiles and pesticides/PCB fractions. Results for these samples are contained in Appendix E.

South Carolina Aquarium Site  
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SUMMARY OF SELECTED SCREENING LEVELS

TABLE 3-1

Source	Long and MacDonald ERM <sup>(1)</sup>	Long and MacDonald ERL <sup>(1)</sup>	EPA Region III Residential Risk Based Concentrations <sup>(2)</sup>	EPA Pine Street Canal Superfund Site <sup>(3)</sup>		EPA People's Natural Gas Superfund Site <sup>(4)</sup>	EPA Proposed SQC (1% OC) <sup>(5)</sup>	Selected Screening Level
Basis		Ecological	Human Health	Human Health	Ecological	Human Health		
<b>VOLATILES (ug/kg)</b>								
Chloromethane	-	-	49,000	-	-	-	-	49,000
Bromomethane	-	-	110,000	-	-	-	-	110,000
Vinyl Chloride	-	-	340	-	-	-	-	340
Chloroethane	-	-	1600 x 10 <sup>3</sup>	-	-	-	-	1600 x 10 <sup>3</sup>
Methylene Chloride	-	-	85,000	-	-	-	-	85,000
Acetone	-	-	7,800 x 10 <sup>3</sup>	-	-	-	-	7,800 x 10 <sup>3</sup>
Carbon Disulfide	-	-	7,800 x 10 <sup>3</sup>	-	-	-	-	7,800 x 10 <sup>3</sup>
1,1-Dichloroethene	-	-	1,100	-	-	-	-	1,100
1,1-Dichloroethane	-	-	7,800 x 10 <sup>3</sup>	-	-	-	-	7,800 x 10 <sup>3</sup>
1,2-Dichloroethene (total)	-	-	700,000	-	-	-	-	700,000
Chloroform	-	-	100,000	-	-	-	-	100,000
1,2-Dichloroethane	-	-	7,000	-	-	-	-	7,000
2-Butanone	-	-	47,000 x 10 <sup>3</sup>	-	-	-	-	47,000 x 10 <sup>3</sup>
1,1,1-Trichloroethane	-	-	7,000 x 10 <sup>3</sup>	-	-	-	-	7,000 x 10 <sup>3</sup>
Carbon Tetrachloride	-	-	4,900	-	-	-	-	4,900
Bromodichloromethane	-	-	10,000	-	-	-	-	10,000
1,2-Dichloropropane	-	-	9,400	-	-	-	-	9,400

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Basis		Ecological	Human Health	Human Health	Ecological	Human Health		
cis-1,3-Dichloropropene	-	-	3,500	-	-	-	-	3,500
Trichloroethene	-	-	58,000	-	-	-	-	58,000
Dibromochloromethane	-	-	7,600	-	-	-	-	7,600
1,1,2-Trichloroethane	-	-	11,000	-	-	-	-	11,000
Benzene	-	-	22,000	-	-	-	-	22,000
Trans-1,3-Dichloropropene	-	-	3,500	-	-	-	-	3,500
Bromoform	-	-	81,000	-	-	-	-	81,000
4-Methyl-2-Pentanone	-	-	3,900 x 10 <sup>3</sup>	-	-	-	-	3,900 x 10 <sup>3</sup>
Tetrachloroethene	-	-	12,000	-	-	-	-	12,000
1,1,2,2-Tetrachloroethane	-	-	3,200	-	-	-	-	3,200
Toluene	-	-	16,000 x 10 <sup>3</sup>	-	-	-	-	16,000 x 10 <sup>3</sup>
Chlorobenzene	-	-	1,600 x 10 <sup>3</sup>	-	-	-	-	1,600 x 10 <sup>3</sup>
Ethylbenzene	-	-	7,800 x 10 <sup>3</sup>	-	-	-	-	7,800 x 10 <sup>3</sup>

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SUMMARY OF SELECTED SCREENING LEVELS

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Source	Long and MacDonald ERM <sup>(1)</sup>	Long and MacDonald ERL <sup>(1)</sup>	EPA Region III Residential Risk Based Concentrations <sup>(2)</sup>	EPA Pine Street Canal Superfund Site <sup>(3)</sup>		EPA People's Natural Gas Superfund Site <sup>(4)</sup>	EPA Proposed SQC (1% OC) <sup>(5)</sup>	Selected Screening Level
Basis		Ecological	Human Health	Human Health	Ecological	Human Health		
Styrene	-	-	16,000 x 10 <sup>3</sup>	-	-	-	-	16,000 x 10 <sup>3</sup>
Xylene (total)	-	-	160,000 x 10 <sup>3</sup>	-	-	-	-	160,000 x 10 <sup>3</sup>
<b>SEMI-VOLATILES</b>								
<b>Polynuclear Aromatic Hydrocarbons (ug/kg)</b>								
Acenaphthene	500	16	4700 x 10 <sup>3</sup>	-	-	-	2,300	16
Acenaphthylene	640	44	-	-	-	-	-	44
Anthracene	1100	85.3	23000 x 10 <sup>3</sup>	-	-	-	-	85.3
Fluorene	540	19	3100 x 10 <sup>3</sup>	-	-	-	-	19
Naphthalene	2100	160	3100 x 10 <sup>3</sup>	-	-	-	-	160
Phenanthrene	1500	240	-	-	-	-	2,400	240
Benzo(a)anthracene	1600	261	880	300-5,000	-	-	-	261
Benzo(a)pyrene	1600	430	88	300-5,000	-	-	-	88
Chrysene	2800	384	88,000	300-5,000	-	-	-	300
Dibenzo(a,h)anthracene	260	63.4	88	300-5,000	-	-	-	63.4
Fluoranthene	5100	600	3100 x 10 <sup>3</sup>	-	-	-	3,000	600
Pyrene	2600	665	2300 x 10 <sup>3</sup>	-	-	-	-	665

South Carolina Aquarium Site  
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SUMMARY OF SELECTED SCREENING LEVELS

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Basis		Ecological	Human Health	Human Health	Ecological	Human Health		
Benzo(b)fluoranthene	-	-	880	300-5,000	-	-	-	300
Benzo(k)fluoranthene	-	-	8,800	300-5,000	-	-	-	300
Benzo(g,h,i)perylene	-	-	-	-	-	-	-	-
Indeno (1,2,3-cd)pyrene	-	-	880	300-5,000	-	-	-	300
TOTAL CaPAH <sup>1</sup> (ug/kg)	-	-	-	2,000-35,000	-	100,000	-	2,000
TOTAL PAH (ug/kg)	44,792	4,022	-	-	13,700-878,400	500,000	-	4,022
							-	
Acid Extractables/Base Neutrals (ug/kg)							-	
2-Methylnaphthalene	670	70	-	-	-	-	-	70
Phenol	-	-	47,000 x 10 <sup>3</sup>	-	-	-	-	47,000 x 10 <sup>3</sup>
bis(2-Chloroethyl)Ether	-	-	580	-	-	-	-	580
2-Chlorophenol	-	-	390,000	-	-	-	-	390,000
1,3-Dichlorobenzene	-	-	7,000 x 10 <sup>3</sup>	-	-	-	-	7,000 x 10 <sup>3</sup>
1,4-Dichlorobenzene	-	-	27,000	-	-	-	-	27,000
1,2-Dichlorobenzene	-	-	7,000 x 10 <sup>3</sup>	-	-	-	-	7,000 x 10 <sup>3</sup>
2-Methylphenol	-	-	3,900 x 10 <sup>3</sup>	-	-	-	-	3,900 x 10 <sup>3</sup>
4-Methylphenol	-	-	390,000	-	-	-	-	390,000

South Carolina Aquarium Site  
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SUMMARY OF SELECTED SCREENING LEVELS

TABLE 3-1

Source	Long and MacDonald ERM <sup>(1)</sup>	Long and MacDonald ERL <sup>(1)</sup>	EPA Region III Residential Risk Based Concentrations <sup>(2)</sup>	EPA Pine Street Canal Superfund Site <sup>(3)</sup>		EPA People's Natural Gas Superfund Site <sup>(4)</sup>	EPA Proposed SQC (1% OC) <sup>(5)</sup>	Selected Screening Level
Basis		Ecological	Human Health	Human Health	Ecological	Human Health		
N-Nitroso-Di-n-Propylamine	-	-	91	-	-	-	-	91
Hexachloroethane	-	-	46,000	-	-	-	-	46,000
Nitrobenzene	-	-	39,000	-	-	-	-	39,000
Isophorone	-	-	670,000	-	-	-	-	670,000
2,4-Dimethylphenol	-	-	1,600 x 10 <sup>3</sup>	-	-	-	-	1,600 x 10 <sup>3</sup>
2,4-Dichlorophenol	-	-	230,000	-	-	-	-	230,000
4-Chloroaniline	-	-	310,000	-	-	-	-	310,000
Hexachlorobutadiene	-	-	8,200	-	-	-	-	8,200
2,4,6-Trichlorophenol	-	-	58,000	-	-	-	-	58,000
2,4,5-Trichlorophenol	-	-	7,800 x 10 <sup>3</sup>	-	-	-	-	7,800 x 10 <sup>3</sup>
2-Chloronaphthalene	-	-	6,300 x 10 <sup>3</sup>	-	-	-	-	6,300 x 10 <sup>3</sup>
2-Nitroaniline	-	-	4,700	-	-	-	-	4,700
Dimethyl Phthalate	-	-	780,000 x 10 <sup>3</sup>	-	-	-	-	7,800 x 10 <sup>3</sup>
2,6-Dinitrotoluene	-	-	160,000	-	-	-	-	160,000
3-Nitroaniline	-	-	230,000	-	-	-	-	230,000
2,4-Dinitrophenol	-	-	160,000	-	-	-	-	160,000
4-Nitrophenol	-	-	4,800 x 10 <sup>3</sup>	-	-	-	-	4,800 x 10 <sup>3</sup>

SUMMARY OF SELECTED SCREENING LEVELS

TABLE 3-1

Source	Long and MacDonald ERM <sup>(1)</sup>	Long and MacDonald ERL <sup>(1)</sup>	EPA Region III Residential Risk Based Concentrations <sup>(2)</sup>	EPA Pine Street Canal Superfund Site <sup>(3)</sup>		EPA People's Natural Gas Superfund Site <sup>(4)</sup>	EPA Proposed SQC (1% OC) <sup>(5)</sup>	Selected Screening Level
Basis		Ecological	Human Health	Human Health	Ecological	Human Health		
2,4-Dinitrotoluene	-	-	160,000	-	-	-	-	160,000
Diethylphthalate	-	-	63,000 x 10 <sup>3</sup>	-	-	-	-	63,000 x 10 <sup>3</sup>
4-Nitroaniline	-	-	230,000	-	-	-	-	230,000
N-Nitrosodiphenylamine (1)	-	-	130,000	-	-	-	-	130,000
4-Bromophenyl-phenylether	-	-	4,500 x 10 <sup>3</sup>	-	-	-	-	4,500 x 10 <sup>3</sup>
Hexachlorobenzene	-	-	400	-	-	-	-	400
Pentachlorophenol	-	-	5,300	-	-	-	-	5,300
Carbazole	-	-	32,000	-	-	-	-	32,000
Butylbenzylphthalate	-	-	16,000 x 10 <sup>3</sup>	-	-	-	-	16,000 x 10 <sup>3</sup>
3,3'-Dichlorobenzidine	-	-	1,400	-	-	-	-	1,400
bis(2-Ethylhexyl)Phthalate	-	-	46,000	-	-	-	-	46,000
Di-n-Octyl Phthalate	-	-	1,600 x 10 <sup>3</sup>	-	-	-	-	1,600 x 10 <sup>3</sup>
<b>PESTICIDES/PCBs (ug/kg)</b>								
alpha-BHC	-	-	100	-	-	-	-	100
beta-BHC	-	-	350	-	-	-	-	350
gamma-BHC (Lindane)	-	-	490	-	-	-	-	490

South Carolina Aquarium Site  
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SUMMARY OF SELECTED SCREENING LEVELS

TABLE 3-1

Source	Long and MacDonald ERM <sup>(1)</sup>	Long and MacDonald ERL <sup>(1)</sup>	EPA Region III Residential Risk Based Concentrations <sup>(2)</sup>	EPA Pine Street Canal Superfund Site <sup>(3)</sup>		EPA People's Natural Gas Superfund Site <sup>(4)</sup>	EPA Proposed SQC (1% OC) <sup>(5)</sup>	Selected Screening Level
Basis		Ecological	Human Health	Human Health	Ecological	Human Health		
Heptachlor	-	-	140	-	-	-	-	140
Aldrin	-	-	38	-	-	-	-	38
Heptachlor epoxide	-	-	70	-	-	-	-	70
Dieldrin	-	-	40	-	-	-	200	40
4,4'-DDE	27	2.2	-	-	-	-	-	2.2
Endrin	-	-	23,000	-	-	-	7.6	7.6
Total DDT	46.1	1.58		-	-	-	-	1.58
Methoxychlor	-	-	390,000	-	-	-	-	390,000
Toxaphene	-	-	580	-	-	-	-	580
TOTAL PCB (ug/kg)	180	22.7	83	-	-	-	-	22.7
<b>METALS (mg/kg)</b>								
Aluminum	-	-	230,000	-	-	-	-	230,000
Antimony	-	-	31	-	-	-	-	31
Arsenic	70	8.2	23	-	-	-	-	8.2
Barium	-	-	5,500	-	-	-	-	5,500
Beryllium	-	-	0.15	-	-	-	-	0.15

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SUMMARY OF SELECTED SCREENING LEVELS

TABLE 3-1

Source	Long and MacDonald ERM <sup>(1)</sup>	Long and MacDonald ERL <sup>(1)</sup>	EPA Region III Residential Risk Based Concentrations <sup>(2)</sup>	EPA Pine Street Canal Superfund Site <sup>(3)</sup>		EPA People's Natural Gas Superfund Site <sup>(4)</sup>	EPA Proposed SQC (1% OC) <sup>(5)</sup>	Selected Screening Level
Basis		Ecological	Human Health	Human Health	Ecological	Human Health		
Cadmium	9.6	1.2	39	-	-	-	-	1.2
Chromium	370	81	390	-	-	-	-	81
Copper	270	34	2,900	-	-	-	-	34
Lead	218	46.7	-	-	-	-	-	46.7
Manganese	-	-	390	-	-	-	-	390
Mercury	0.71	0.15	23	-	-	-	-	0.15
Nickel	51.6	20.9	1,600	-	-	-	-	20.9
Selenium	-	-	390	-	-	-	-	390
Silver	3.7	1.0	390	-	-	-	-	1.0
Vanadium	-	-	550	-	-	-	-	550
Zinc	410	150	2,300	-	-	-	-	150
Cyanide		-	1,600	-	-	-	-	1,600
DIOXIN (ug/kg)								
2,3,7,8-TCDD	-	-	0.0043	-	-	-	-	0.0043

SUMMARY OF SELECTED SCREENING LEVELS

TABLE 3-1

- † Total Carcinogenic PAHs include: benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenzo(a,h)anthracene, indeno(1,2,3-c,d)pyrene.
- [1] Effects Range - Low (ERL) and Effects Range - Median (ERM) as described in: Long, Edward R., National Oceanic and Atmospheric Administration (NOAA), Donald D. MacDonald et al., MacDonald Environmental Sciences Limited, 1993, "Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments", Environmental Management (Accepted 11/6/93).
- [2] Risk-based concentration in residential soil for a lifetime cancer risk of  $10^{-6}$  or a hazard quotient of 1, as listed in: Smith, Roy L., USEPA Region III Technical Support Section, January 1994, Risk-Based Concentration Table First Quarter 1994.
- [3] Project Remedial Goals (PRGs) and Ecological Effect Levels as defined in: Metcalf & Eddy, Inc., November 1992, Feasibility Study Final Report, Pine Street Canal Superfund Site, Burlington, Vermont. For the Human Health Based PRG the lower end of the range is based on an estimated risk of  $10^{-6}$  for each compound and  $7 \times 10^{-6}$  overall, using a site use scenario of recreation, conservation and open space. The upper end of the range is based on an estimated risk of  $10^{-5}$  for each compound and  $7 \times 10^{-5}$  overall, using an industrial site use scenario. The Ecological Effect Level range represents various habitats, including emergent wetland (low end of the Effects Level range), upland, canal sediments, and wooded wetlands (high end of the Effects Level range).
- [4] USEPA, 1991, Human Health Based Cleanup Level for soil, as defined in: Superfund Record of Decision (EPA Region 7): People's Natural Gas Coal Gasification Site, Dubuque, Iowa (First Remedial Action), September 1991.
- [5] EPA Proposed Sediment Quality Criteria for the Protection of Benthic Organisms in Saltwater, Normalized to 1% Organic Carbon. "Sediment Quality Criteria; Notice". Federal Register. Tuesday, January 18, 1994. page 2655.

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UPLAND SOILS - HORIZON A SOIL SAMPLING RESULTS

TABLE 3-2

SAMPLE NO.	B01-03 *	B02-03 *	B03-03 *	B08-03 *	B07-03 *	B08-03 *	B08-03	B10-03 *	B13-03	B14-03 *	B14D03 *	B16-03
<b>SEMI-VOLATILES (ug/kg)</b>												
<b>Polynuclear Aromatic Hydrocarbons</b>												
Naphthalene	260 J	240 J	380 ND	2100	680 DJ	260 J	380 ND	410 J	780 ND	400 ND	400 ND	380 ND
Acenaphthylene	170 J	480 J	67 J	1800 ND	670 DJ	300 J	80 J	3800 ND	81 J	400 ND	400 ND	210 J
Acenaphthene	98 J	560 J	53 J	9100	8700 D	3200	81 J	1100 J	910	48 J	120 J	140 J
Fluorene	84 J	490 J	40 J	7800	8100 D	1400 J	380 ND	880 J	1200	400 ND	400 ND	110 J
Phenanthrene	440	4100	350 J	34000	23000 D	4800	250 J	3600 J	1800	100 J	89 J	400
Anthracene	140 J	870 J	100 J	16000	7600 D	2700	180 J	880 J	850	400 ND	400 ND	240 J
Fluoranthene	1200	8400	840	40000 B	28000 D	14000	560	3500 J	6100	180 J	220 BJ	1000
Pyrene	1200	6300	760	28000 B	18000 D	13000	1100	3700 J	6800	210 J	280 J	830
Benzo(a)anthracene	840	3700	640	6700 B	10000 D	9700	380 ND	2300 J	2400	140 J	130 J	910
Chrysene	710	2800	400	13000	11000 D	9500	670	1700 J	1500	150 J	180 J	1200
Benzo(b)fluoranthene	1300 X	4200 X	670 X	18000	11000 DX	10000 X	380 ND	3100 JX	2800 X	380 JX	400 X	3300 X
Benzo(k)fluoranthene	1300 X	4200 X	670 X	7700	11000 DX	10000 X	380 ND	3100 JX	2800 X	380 JX	400 X	3300 X
Benzo(a)pyrene	660	2400	340 J	9800 B	4700 D	2600	870	1700 J	1100	150 J	130 J	1000
Dibenz(e,h)anthracene	180 J	230 J	78 J	740	970 DJ	740 J	380 ND	3800 ND	210 J	98 J	400 ND	380 ND
Indeno(1,2,3-cd)pyrene	480	920 J	260 J	8100	2800 DJ	2300	380 ND	1200 J	850 J	210 J	180 J	620
Benzo(g,h,i)perylene	330 J	470 J	240 J	4200 B	1800 DJ	1800 ND	380 ND	480 J	510 J	240 J	180 J	470
TOTAL PAHs (ug/kg)	8402	37670	6388	201340	142620	84300	3481	27860	28611	2285	2338	13730
TOTAL CalPAHs (ug/kg)	6480	18660	2868	60040	61270	44140	1240	13100	11480	1508	1440	10330
<b>Acid Extractables/Base Neutrals</b>												
2-Methylnaphthalene	250 J	200 J	380 ND		1500 DJ	280 J	380 ND	590 J	780 ND	400 ND	400 ND	340 J
Carbazole	380 ND	1600 ND	380 ND		1800 DJ	230 J	380 ND	700 J	780 ND	400 ND	400 ND	62 J
<b>METALS (mg/kg)</b>												
Antimony	9.8 ND	9.8 ND	9.8 ND	12	11.3	9.8 ND	9.8 ND	9.7 ND	10 ND	10.2 ND	10.1 ND	9.8 ND
Arsenic	1.7 B	4.1	4.3	2.7	7.8	2.3 D	3.6	2.6	2.8	1.7 B	1.9 B	6.1
Beryllium	0.85 ND	0.84 ND	0.85 ND	0.42 ND	0.83 ND	0.85 ND	0.84 ND	0.83 ND	0.86 ND	0.88 ND	0.87 ND	0.85 ND
Cadmium	1 ND	1.6	1 ND	0.67 B	0.98 ND	1 ND	1 ND	0.98 ND	1 ND	1 ND	1 ND	1 ND
Chromium	23.7	51.6	36	127	43.8	18	30.2	10.1	18.1	10.7	8.8	38.3
Copper	327	106	44	272	131	9.7	79.6	36.9	3 ND	16	25.7	57.9
Lead	147	278	105	733	356	16	651	130	40.6	41.6	14.6	108
Manganese	89	270	62.6		130	30.7	61.2	145	35.4	18.9	20.9	84.3
Mercury	0.61	0.8	0.34	2.2	0.71	0.12 ND	0.6	0.12 ND	0.12 ND	0.12 ND	0.12 ND	1
Nickel	9.1 B	28.9	8.2 ND	8.1	22.6	8.2 ND	15	10.8	8.3 ND	8.5 ND	8.4 ND	12.2
Silver	1.8 ND	1.8 ND	1.8 ND	0.9 ND	1.8 ND	1.8 ND	1.8 ND	1.8 ND	1.8 ND	1.9 ND	1.9 ND	1.8 ND
Vanadium	18.8	43.4	26.4		48.8	24.3	35.1	12.9	20.8	13.8	12.7	38.4
Zinc	241	567	151	506	422	33.7	3860	147	31	44.8	46.1	153
<b>PESTICIDES/PCBs (ug/kg)</b>												
Dieldrin	2.7 JP	4.7 P	1.1 JP		19 ND	5 JP	2.1 J	3.8 ND	3.9 ND	4 ND	4 ND	0.31 JP
4,4'-DDE	1.5 JP	3.9 ND	4.7		56 D	2.9 JP	0.49 JP	0.74 JP	0.13 JPB	4 ND	0.18 JP	2 JP
4,4'-DDT	3.9 ND	3.9 ND	4.8 P		19 ND	19 ND	3.8 ND	3.8 ND	2.4 JP	0.48 JP	0.2 JP	13
Aroclor-1254	38 ND	38 ND	38 ND	23 ND	800 CD	190 ND	38 ND	38 ND	38 ND	40 ND	40 ND	78 ND
Aroclor-1280	180	230	38 ND	130	200 D	180 ND	38 ND	38 ND	38 ND	10 ND	40 ND	78 ND
TOTAL PCBs (ug/kg)	180	230	0	130	1060	0	0	0	0	0	0	0

\* Pre-selected sample

South Carolina Aquarium Site  
Charleston, South Carolina  
UPLAND SOILS - HORIZON A SOIL SAMPLING RESULTS  
TABLE 3-2 (Continued)

SAMPLE NO.	B17-03 *	B17D03 *	B18-03 *	B20-03	B21-03*	B24-03*	B26-03 *	B27-03 *	B28-02 *	B28-01 *	B30-03*	B31-03*
<b>SEMI-VOLATILES (ug/kg)</b>												
<b>Polynuclear Aromatic Hydrocarbons</b>												
Naphthalene	58 J	120 J	4500	7800 ND	3400 D	1800 ND	88 J	850 ND	700 ND	140	14 JB	38 JB
Acenaphthylene	91 J	130 J	3900 ND	7600 ND	2000 ND	1600 ND	380 ND	830 ND	870 ND	30 ND	12 JB	18 J
Acenaphthene	41 J	86 J	1900 J	5800 J	4500 D	1600 ND	390 ND	580 ND	600 ND	27 ND	84 J	150 ND
Fluorene	44 J	84 J	3000 J	5200 J	3100 D	1800 ND	390 ND	1100 ND	1100 ND	51 ND	35 JB	550 B
Phenanthrene	630	780	11000	18000	8000 D	470 DJ	110 J	2300	840	120 B	280	290
Anthracene	240 J	220	4200	5500 J	1200 DJ	250 DJ	390 ND	7000	2500	18 ND	7100	90 ND
Fluoranthene	1900	1800	10000	12000	3800 D	1300 DJ	88 J	3800	2500	26 B	2400	500
Pyrene	1800	1500	9200	6500 J	2200 D	1800 DJ	120 J	2800	2300	18 B	1900	370
Benzo(a)anthracene	1100	1000	4800	3500 J	1000 DJ	820 DJ	91 J	1000	700 B	6.5 ND	850	130
Chrysene	1700	1200	5400	3500 J	820 DJ	870 DJ	74 J	850	500	9.6 ND	830	140
Benzo(b)fluoranthene	1900 X	1900 X	6200 X	3300 JX	1600 DJX	1500 DJX	210 JX	2000	1100	22	920	170
Benzo(k)fluoranthene	1900 X	1900 X	6200 X	3300 JX	1600 DJX	1500 DJX	210 JX	1200 B	510	6.3 JB	140	100
Benzo(a)pyrene	680	810	2500 J	1400 J	650 DJ	640 DJ	87 J	1500 B	750 B	0.91 JB	1300	120 B
Dibenz(a,h)anthracene	180 J	130 J	3900 ND	7800 ND	2000 ND	1600 ND	390 ND	120 J	48 J	7.8 ND	43 B	4.9 J
Indeno(1,2,3-cd)pyrene	420	420	1900 J	7600 ND	2000 ND	230 DJ	78 J	1300	560	10	940	88
Benzo(g,h,i)perylene	210 J	380	1400 J	7800 ND	2000 ND	1800 ND	300 ND	1100	540	8.5 ND	380	48
TOTAL PAHs (ug/kg)	12874	12410	72200	68000	31570	8880	1152	24970	12848	343.21	17208	2584.9
TOTAL CaPAHs (ug/kg)	7880	7380	27000	16000	6570	6300	750	2970	4188	38.21	6023	750.8
<b>Acid Extractables/Base Neutrals</b>												
2-Methylnaphthalene	62 J	120 J	18000	1500 J	2700 D	1800 ND	120 J					
Carbazole	100 J	130 J	3900 ND	7600 ND	2000 ND	1800 ND	390 ND					
<b>METALS (mg/kg)</b>												
Antimony	35.8	19.5	31.2	27.8	10 ND	65	58	20	5.1 ND	35.7	70.8	6.1 ND
Arsenic	9.1	11.1	8.1	14.8 B	7.8	2.8	8.6	37.3	14.5	2	17.2	3.1
Beryllium	0.84 ND	0.83 ND	0.86 ND	3.5	0.86 ND	0.89 ND	0.84 ND	0.38 ND	0.44 ND	0.89	1.5	0.46 B
Cadmium	1.8	1 ND	1.7	1.4	1.1 B	2.1	1.9	1.5	0.97	1.3	3.5	0.53 ND
Chromium	33.7	43.5	45.7	383	64.8	82	75.8	104	94.2	45.8	107	18.3
Copper	1850	208	247	274	621	280	188	1090	473	1870	600	7.8
Lead	750	308	255	223	270	829	824	475	327	201	733	8.1
Manganese	145	139	148	565	71.4	425	276					
Mercury	0.89	1.3	1.1	1.5	6.5	0.17	0.37	4	2.6	0.11 ND	0.57	0.17
Nickel	25.2	24.5	18.9	104	14.4	58.6	37.7	23.8	11.2	84.8	141	6
Silver	1.8 ND	1.8 ND	1.8 ND	1.8 ND	1.8 ND	1.8 ND	1.8 ND	0.77 ND	0.83 ND	0.84 ND	0.82 ND	0.84 ND
Vanadium	61.8	73.9	73.7	218	24.7	73	187					
Zinc	1220	536	598	598	817	1280	892	942	760	548	1840	21.7
<b>PESTICIDES/PCBs (ug/kg)</b>												
Dieldrin	1.4 JP	1.5 JP	5.2 JPD	3.8 ND	3.3 JP	4.1 ND	0.78 JP					
4,4'-DDE	2.4 JP	11 P	13 JPD	11 P	2.5 JP	0.67 JP	4.5					
4,4'-DDT	1 JP	51	47 PD	2.8 JP	4.5 P	4.1 ND	14 P					
Arochlor-1254	39 ND	38 ND	200 ND	38 ND	39 ND	41 ND	38 ND	22 ND	24 ND	22 ND	23 ND	24 ND
Arochlor-1260	39 ND	38 ND	220 PD	330 Y	39 ND	82 P	73 P	180	310	22 ND	180 P	25
TOTAL PCBs (ug/kg)	0	0	220	330	0	82	73	180	310	0	180	25

\* Pre-selected sample

South Carolina Aquarium Site  
Charleston, South Carolina  
UPLAND SOILS - HORIZON A SOIL SAMPLING RESULTS  
TABLE 3-2 (Continued)

SAMPLE NO.	833-03 *	834-03 *	835-03 *	838-04 *	838-02 *	839-02	840-03 *	841-03 *	842-03 *	843-03 *	844-02 *	848-02 *
<b>SEMI-VOLATILES (ug/kg)</b>												
<b>Polynuclear Aromatic Hydrocarbons</b>												
Naphthalene	370 J	200 DJ	210 JB	320	3.5 ND	360 ND	52 J	670 ND	7700 ND	230	480 J	2000 ND
Acenaphthylene	640 J	280 DJ	320 J	84 ND	3.4 ND	360 ND	400 ND	37 JB	7700 ND	180 ND	820 ND	2000 ND
Acenaphthene	5800	550 DJ	210 JB	510	3 ND	64 J	54 J	55 JB	3000 J	270	1800	1700 ND
Fluorene	1400 J	370 DJ	220 JB	370	80 B	680 ND	400 ND	280 JB	7700 ND	270 ND	4800	3300 ND
Phenanthrene	8300	3300 D	2000	1400	98	3000	330 J	1200	3800 J	2100	31000	4800
Anthracene	1800 J	1000 D	3800	4100	340	1400	97 J	300 ND	4300 J	8100	18000	1000 ND
Fluoranthene	7700	8200 D	360	2900	200	8000	590	740	7400 J	5800	27000	11000 B
Pyrene	11000	5100 D	120 J	3100	160	8800	830	740 B	8000 J	5800	18000	8100 B
Benzo(a)anthracene	11000	3800 D	14 JB	780 B	60 B	2900	550	160 B	6200 J	1800	5800	3500 B
Chrysene	8400	3500 D	500	1200	4.5	3300	710	300	5200 J	2000	4400	4100
Benzo(b)fluoranthene	15000 X	3500 DX	820	1000	9.3	4500	1200 X	180 B	7600 JX	2700	4700	3700
Benzo(k)fluoranthene	15000 X	3500 DX	140 J	520	54	2700	1200 X	200 B	7600 JX	1600 B	3800 B	3500
Benzo(a)pyrene	4500	1700 D	50 J	840 B	57 B	2400	420	5.7 JB	2700 J	2100	3800 B	3800 B
Dibenz(a,h)anthracene	800 J	340 DJ	28 J	110	3.1	220	110 J	37 J	7700 ND	150	280	150 J
Indeno(1,2,3-cd)pyrene	2800	1100 D	220 ND	880	51	1800	260 J	180 ND	2000 J	1100	2200	1800
Benzo(g,h,i)perylene	2400	900 D	62 J	730	47	1100	280 J	160 B	1700 J	910	1500	1800 B
TOTAL PAHs (ug/kg)	94710	35340	8434	18540	1171.9	40184	8883	4114.7	58800	34880	127650	48350
TOTAL CaPAHs (ug/kg)	57800	17440	1362	5110	239.8	17820	4450	892.7	30300	11250	24780	20550
<b>Acid Extractables/Base Neutrals</b>												
2-Methylnaphthalene	2000 ND	140 DJ					43 J		7700 ND			
Carbazole	1200 J	130 DJ					71 J		7700 ND			
<b>METALS (mg/kg)</b>												
Antimony	28.1	21.4	14	37.5	5 ND	8.3	10.3 ND	4.8 ND	17.5	14.7	31.8	8.7
Arsenic	13	9.7	36.8	14.8	8.3	7.7	4.8	3.2	19	20.4	12.1	13.3
Beryllium	0.88 ND	0.87 ND	0.41 ND	0.42 ND	2	0.88	1.7	0.58	0.84 ND	0.42 ND	1.8	0.51 ND
Cadmium	1.3	1.3	2.3	1.5	0.52 ND	0.53 ND	1.1 ND	0.49 ND	1 ND	1.3	3.8	1.4
Chromium	81.1	78	114	258	6.7	43.4	14.2	12.8	208	52.8	83.4	47
Copper	505	471	1260	1330	122	267	108	28.8	1180	201	778	222
Lead	437	482	813	883	70.4	388	99.8	41.6	813	207	738	538
Manganese	851	251					245		231			
Mercury	1.8	1.4	7.3	8	0.31	1.3	3	0.38	10.5	0.58	0.88	1.4
Nickel	55.1	42.2	23.1	728	10.1	19.8	43.3	44	54	55.7	109	15.8
Silver	1.8 ND	1.8 ND	0.88 ND	0.88 ND	0.83 ND	0.86 ND	1.8 ND	0.88 ND	1.8 ND	0.81 ND	0.84 ND	1.1 ND
Vanadium	184	129					218		107			
Zinc	1110	854	1580	1770	157	822	157	143	1770	448	7850	543
<b>PESTICIDES/PCBs (ug/kg)</b>												
Dieldrin	1.8 JP	3.8 JP					1.2 JP		380 ND			
4,4'-DDE	4 ND	82					10 P		230 JPD			
4,4'-DDT	38 P	44 P					34		58 JPD			
Arochlor-1254	40 ND	200 ND	23 ND	270 P	24 ND	26 ND	40 ND	230 ND	3800 ND	500	22 ND	28 ND
Arochlor-1260	40 ND	200 ND	230	180	90 P	130	40 ND	230 ND	3800 ND	24 ND	350	130
TOTAL PCBs (ug/kg)	0	0	230	480	90	130	0	0	0	500	350	130

\* Pre-selected sample

South Carolina Aquarium Site  
Charleston, South Carolina  
UPLAND SOILS - HORIZON A SOIL SAMPLING RESULTS  
TABLE 3-2 (Continued)

SAMPLE NO.	B60-02 *	B62-01 *	B63-01 *	B66-02	B67-02 *	B68-01 *	B60-02 *	B61-01 *	B88-03 *	B89-03 *	B90-03 *	B91-03 *
<b>SEMI-VOLATILES (ug/kg)</b>												
<b>Polynuclear Aromatic Hydrocarbons</b>												
Naphthalene	780	180 J	190 DJ	390 JB	680 ND	320 ND	280 JB	4400 ND	210	180 J	300	34 J
Acenaphthylene	44 J	820 ND	1900 ND	180 JB	660 ND	300 ND	84 J	4400 ND	140	400 ND	32 J	78 ND
Acenaphthene	430	880	720 DJ	840 JB	680 ND	270 ND	320 JB	4400 ND	88	400 ND	81	71 ND
Fluorene	340 J	820 J	480 DJ	2300 B	1100 ND	510 ND	1100 ND	4400 ND	440	400 ND	200	130 ND
Phenanthrene	2100	3100	4800 D	33000	3700 D	1500	3100	1200 DJ	11000	220 J	1400	410
Anthracene	470	850	880 DJ	100000	15000 D	180 ND	8000	1300 DJ	2500	400 ND	780	1000
Fluoranthene	2100	2900	6100 D	70000	12000 D	2200 B	4400	18000 D	3500	280 J	150	480
Pyrene	1900	2200	5000 D	43000	8800 D	2800 B	3300 B	17000 D	3300	180 J	230	320
Benzo(a)anthracene	1300	1800	3400 D	13000 B	2800 D	1000 B	1500	15000 D	1400 B	280 J	28 B	6 JB
Chrysene	1200	1500	2700 D	900	4700 D	1400 B	270	13000 D	1400	180 J	1100	140
Benzo(b)fluoranthene	1800 X	2200 X	3800 DX	1800	6100 D	1700 B	200	29000 DX	1700	350 JX	770	180
Benzo(k)fluoranthene	1800 X	2200 X	3800 DX	1800	3800 BD	1200 B	1100 B	29000 DX	880 B	350 JX	150	20 ND
Benzo(a)pyrene	880	1100	2100 D	13000	3100 BD	1500 B	1500	13000 D	1100 B	140 J	520 B	2.3 J
Dibenz(a,h)anthracene	180 J	300 J	480 DJ	540	350 D	240	80 J	2800 DJ	71	400 ND	77	4.7 J
Indeno(1,2,3-cd)pyrene	400	780 J	1800 DJ	8800	16000 D	960	1100	6800 D	700	400 ND	270	140
Benzo(g,h,i)perylene	370	580 J	1200 DJ	1800	1700 D	1100 B	1300	4500 D	500	400 ND	340	8.2 J
TOTAL PAHs (ug/kg)	10094	20860	30140	201630	77850	15800	24524	147400	28907	2110	8418	2705.2
TOTAL CaPAHs (ug/kg)	7650	9880	17890	40540	36850	8000	5730	107400	7251	1280	2013	473
<b>Acid Extractables/Base Neutrals</b>												
2-Methylnaphthalene	980	210 J	1800 ND					4400 ND		220 J		
Carbazole	380 J	580 J	540 DJ					4400 ND		400 ND		
<b>METALS (mg/kg)</b>												
Antimony	32.3	166	85.5	18.8	10 ND	20.6	57.4	130	4.8 ND	10.3 ND	28.8	6 ND
Arsenic	19.8	44.1	28.9	24.7	19.4	8.3	9.5	130	8.7	3.8	13.2	3.6
Beryllium	1 B	1.7	9.2	2.1	2.1	0.54 B	1.8	0.86 ND	0.8	0.89 ND	0.48 ND	0.51 ND
Cadmium	4.8	43.7	8.8	0.8 ND	1 ND	1.1	0.88	27	1.1	1.1 ND	4.1	0.81 ND
Chromium	214	545	571	138	60.2	83.3	93.3	298	40.7	24.4	78.8	3.4
Copper	458	2000	2310	1030	182	497	832	11600	108	131	320	28.9
Lead	880	5480	43600	1230	250	827	1530	16200	888	113	517	88.8
Manganese	858	1040	1350					2120		118		
Mercury	0.71	3.2	2.2	5	1.2	2.2	2.8	2.1	0.28	1.3	0.43	0.42
Nickel	188	132	1510	53.2	28.9	71.8	42.5	241	28.6	20.4	45.3	4.8 ND
Silver	1.7 ND	3.2	4.6	1.8 ND	1.8 ND	0.64 ND	0.81 ND	4.5	0.9 ND	1.8 ND	0.97 ND	1.1 ND
Vanadium	989	1200	13000					419		17.7		
Zinc	922	7200	3530	1180	648	920	1280	8840	582	427	1730	56.5
<b>PESTICIDES/PCBs (ug/kg)</b>												
Dieldrin	1.1 JP	41 ND	2.3 JPD					1.8 JP		4 ND		
4,4'-DDE	15 JP	34 JPD	88 D					78 P		4 ND		
4,4'-DDT	58	150 D	480 CD					12 JP		4 ND		
Arochlor-1254	180 ND	410 ND	380 ND	42 ND	47 ND	12000	23 ND	220 ND	23 ND	180	25 ND	70
Arochlor-1260	180 ND	410 ND	380 ND	1100	150	110 ND	580	220 ND	78	40 ND	87	28 ND
TOTAL PCBs (ug/kg)	0	0	0	1100	150	12000	580	0	78	180	87	70

\* Pre-selected sample

## DATA REPORTING QUALIFIERS FOR ORGANICS

- VALUE - If the result is a value greater than or equal to the Contract Required Quantitation Limit (CRQL), report the value.
- ND or U - Indicates analyte was analyzed for but not detected.
- J - Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the sample quantitation limit but greater than zero.
- N - Indicates presumptive evidence of a compound. This flag is only used for tentatively identified compounds.
- P - This flag is used for a pesticide/Aroclor target analyte when there is greater than 25% difference for detected concentrations between the two GC columns. The lower of the two values is reported on Form I and flagged with a "P".
- C - This flag applies to pesticide results where the identification has been confirmed by GC/MS.
- B - This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action. **The results have been flagged with this qualifier even if the analyte was found in the associated blank at acceptable levels (i.e. less than the CRQL).**
- E - This flag identifies compounds whose concentrations exceed the calibration range of the GC/MS instrument for the specific analysis.
- D - This flag identifies all compounds identified in an analysis at a secondary dilution factor.
- X - Other specific flags and footnotes required to properly define the results.
- Y - The "Y" flag is used to denote pesticide/PCB compounds that could not be confirmed by GC/MS. The results from the GC/MS confirmation are included in the sample data package.

## DATA REPORTING QUALIFIERS FOR INORGANICS

### C (Concentration) Qualifiers:

- B - The reported value was obtained from a reading that was less than the Contract Required Detection Limit (CRDL) but greater than or equal to the Instrument Detection Limit (IDL).
- ND or U - Indicates analyte was analyzed for but not detected.

### Q Qualifier:

- E - The reported value is estimated because of the presence of interference.
- M - Duplicate injection precision not met.
- N - Spiked sample recovery not within control limits.
- A or S - The reported value was determined by the Method of Standard Additions (MSA).
- W - Post-digestion spike for Furnace AA analysis is out of control limits (85-115%), while sample absorbance is less than 50% of spike absorbance.
- \* - Duplicate analysis not within control limits.
- + - Correlation coefficient for the MSA is less than 0.995.

### M (Method) Qualifier:

- "P" - for ICP
- "A" - for Flame AA
- "F" - for Furnace AA
- "PM" - for ICP when Microwave Digestion is used
- "AM" - for Flame AA when Microwave Digestion is used
- "FM" - for Furnace AA when Microwave Digestion is used
- "CV" - for Manual Cold Vapor AA
- "AV" - for Automated Cold Vapor AA
- "CA" - for Midi-Distillation Spectrophotometric
- "AS" - for Semi-Automated Spectrophotometric
- "C" - for Manual Spectrophotometric
- "T" - for Titrimetric
- " " - where no data has been entered
- "NR" - if the analyte is not required to be analyzed.

South Carolina Aquarium Site  
Charleston, South Carolina  
UPLAND SOILS - HORIZON B SOIL SAMPLING RESULTS  
TABLE 3-3

SAMPLE NO.	B04-08 *	B06-08 *	B11-04 *	B12-07*	B18-07	B18-09*	B20-09*	B22-02	B26-07 *	B31-09 *	B32-07 *	B34-08
<b>SEMI-VOLATILES (ug/kg)</b>												
<b>Polynuclear Aromatic Hydrocarbons</b>												
Naphthalene	390 ND	1.1 J	1.8 JB	30 JB	2900	3.7 ND	780	210 JB	100 B	940 B	400 ND	230
Acenaphthylene	390 ND	3.3 ND	2.4 JB	12 JB	34 ND	2.3 JB	9.5	100 JB	1.7 JB	12 J	400 ND	41 J
Acenaphthene	88 J	92	16 ND	180	2300	3.2 ND	1100	260 JB	77 B	2000 B	62 J	5400
Fluorene	88 J	5.5 ND	320 B	110 B	2500	760 B	5.9 ND	980 B	6.7 ND	990 B	400 ND	3800
Phenanthrene	300 J	61	230	240	4800	5.1	380	15000	33	7800	400 ND	25000
Anthracene	110 J	32	980	1300	2200	1.9 ND	41	8700	21	3000	400 ND	5800
Fluoranthene	230 J	89 B	810 B	2300	2200	3	0.89 ND	9800	21	6500	93 J	8200
Pyrene	180 J	58 B	650 B	1700	2000	2.7	1 ND	5500	15	140	93 J	4800
Benzo(a)anthracene	100 J	16 B	180 B	550	380	0.82 B	0.78 ND	2000 B	4.2	1200	53 J	1300
Chrysene	90 J	13	400	89	880	1.1 ND	280	110 ND	11	720	44 J	1800
Benzo(b)fluoranthene	98 JX	18	20 B	90	180	0.73 J	0.7 J	1200	0.82 J	700	64 JX	1100
Benzo(k)fluoranthene	98 JX	10	24 B	440 B	140 B	0.59 J	2.8	990	3.9 B	50 J	64 JX	680
Benzo(a)pyrene	390 ND	16 B	220 B	630 B	150	0.97 B	4	1500	4.4 B	810 B	42 J	910
Dibenz(a,h)anthracene	390 ND	0.38 J	4.2 ND	27	10	0.89 ND	0.25 J	85 ND	0.14 J	31 J	400 ND	54
Indeno(1,2,3-cd)pyrene	390 ND	9.6	180 B	290	68	1 ND	1 ND	940	3.3	210	400 ND	530
Benzo(g,h,i)perylene	390 ND	7.7 B	130 B	78	37	3.2	2.4	1200	1.4	17 J	400 ND	280
TOTAL PAHs (ug/kg)	1378	392.78	4028	7950	20295	769.41	2810.85	40380	297.88	23720	506	57925
TOTAL CaPAHs (ug/kg)	388	81.88	1024	1880	1668	3.11	287.75	8830	27.78	3621	287	8374
<b>Acid Extractables/Base Neutrals</b>												
2-Methylnaphthalene	390 ND										400 ND	
Carbazole	390 ND										400 ND	
<b>METALS (mg/kg)</b>												
Antimony	10.2 ND	5 ND	7 ND	15.2	6.2 ND	5.3 ND	5.3 ND	23.4	5.1 ND	5.4 ND	10.2 ND	5.2 ND
Arsenic	2.2 B	1.9	5.8	38.9	3.2	2.3	1.3	85.5	4	7.8	2.1 B	3
Beryllium	0.87 ND	0.22	0.6 ND	0.45 B	0.44 ND	0.46 ND	0.46 ND	1.1	0.47 B	0.48 ND	0.88 ND	0.45 ND
Cadmium	1 ND	0.51 ND	0.72 ND	1	0.53 ND	0.55 ND	0.54 ND	0.89	0.53 ND	0.55 ND	1.1 ND	0.53 ND
Chromium	9.5	18.4	27.9	75	12.2	13.1	9.8	155	8.7	14.8	10.8	20
Copper	3.1 ND	1.5 B	60.4	242	12.9	1.8 ND	1.6 ND	813	1.8 ND	1.8 ND	3.1 ND	12.3
Lead	18.9	8.7	447	205	8.1	23.3	4.2	2280	4	10.1	4.8	45.8
Manganese	45.4										8.5	
Mercury	0.12 ND	0.12 ND	1.2	0.37	0.12 ND	0.13 ND	0.13 ND	0.72	0.12 ND	0.13 ND	0.12 ND	0.27
Nickel	8.4 ND	4.2 ND	5.8 ND	63.1	4.3 ND	4.4 ND	4.4 ND	65.7	4.3 ND	4.4 ND	8.5 ND	4.3 ND
Silver	1.9 ND	0.82 ND	1.3 ND	0.95 ND	0.95 ND	0.98 ND	0.98 ND	0.94 ND	0.95 ND	0.98 ND	1.9 ND	0.98 ND
Vanadium	11.1 B										12.7	
Zinc	20.2	9.9	77.4	392	13.8	11.8	11.8	994	5.4	10.1	10.5	73.8
<b>PESTICIDES/PCBs (ug/kg)</b>												
Dieldrin	3.9 ND										4 ND	
4,4'-DDE	0.28 JBP										4 ND	
4,4'-DDT	3.9 ND										4 ND	
Arochlor-1254	39 ND	24 ND	240 ND	25 ND	24 ND	25 ND	25 ND	120 ND	24 ND	28 ND	40 ND	25 ND
Arochlor-1260	39 ND	24 ND	240 ND	21 JP	24 ND	25 ND	25 ND	6400	24 ND	28 ND	40 ND	25 ND
TOTAL PCBs (ug/kg)	0	0	0	21	0	0	0	6400	0	0	0	0

South Carolina Aquarium Site,  
Charleston, South Carolina  
UPLAND SOILS - HORIZON B SOIL SAMPLING RESULTS  
TABLE 3-3 (Continued)

SAMPLE NO.	B36-07	B36-08 *	B42-10 *	B44-08	B46-07	B48-07	B51-06	B53-08 *	B56-08 *	B60-06	B69-02	B69-07 *	B70-07 *
<b>SEMI-VOLATILES (ug/kg)</b>													
<b>Polynuclear Aromatic Hydrocarbons</b>													
Naphthalene	9300 ND	2200	1300	1200	1000 ND	850 ND	300 JB	200 B	800 ND	240 JB	70 JB	7.3 JB	1300 DJ
Acenaphthylene	9300 ND	630	10	720 ND	970 ND	850 ND	70 J	37 JB	140 J	100 J	230 J	34 ND	1700 DJ
Acenaphthene	10000	15000	880	9200	9700	1800	1200 B	100 J	110 J	390 B	43 JB	2.5 J	15000 D
Fluorene	7000 J	5800	6.7 ND	9500	5800	1600	820 J	860 B	800 ND	540 J	850 J	9.1 J	11000 D
Phenanthrene	17000	9400	45	27000	19000	4500	12000	980	280 J	4500	4000	97	40000 D
Anthracene	4500 J	2000	320	25000	520 ND	1000	12000	97 ND	250 J	200 ND	8300	120 B	12000 D
Fluoranthene	17000	13000 B	0.84 ND	19000	9400	2900	6400	670	2400	3100 B	4100	89	36000 D
Pyrene	12000	12000 B	0.95 ND	13000	380	2300	13000	980 B	2400	4100 B	4700	660	28000 D
Benzo(a)anthracene	5800 J	4800 B	2.7	4500	1800 B	1300	4100	300 B	1400	830	2700	65 B	18000 D
Chrysene	3800 J	3900 B	150	2800	2000	1500	3500 B	960	1300	1100	3000 B	420	15000 D
Benzo(b)fluoranthene	4900 JX	4300	42	3500	4100	2000 X	3800	410	2000 X	830	3300	120	18000 DX
Benzo(k)fluoranthene	4900 JX	2700 B	46	2600 B	380	2000 X	2700 B	200 B	2000 X	480 B	2200 B	68 B	19000 DX
Benzo(a)pyrene	2800 J	4500 B	59	4200 B	120 J	600 J	4400	4.8 JB	880	670	3800	100 B	11000 D
Dibenz(a,h)anthracene	9300 ND	710	5.5	390	100 J	950 ND	390	70	210 J	210	430	9.1	1700 DJ
Indeno(1,2,3-cd)pyrene	1500 J	2300	26	15000	540	300 J	2800	340	480 J	340	2000	9.8 ND	5600 DJ
Benzo(g,h,i)perylene	1100 J	2000	22	280	180 J	180 J	2000	210	300 J	2400	2500	85	3400 DJ
TOTAL PAHs (ug/kg)	92300	84840	27011.2	137260	53580	21080	60480	6120.8	14170	18830	43223	1832	238700
TOTAL C <sub>2</sub> PAHs (ug/kg)	23700	23010	331.2	33080	8040	7700	21800	2202.0	11730	4480	18430	782.1	89300
<b>Acid Extractables/Base Neutrals</b>													
2-Methylnaphthalene	2800 J					120 J			800 ND				6800 ND
Carbazole	9300 ND					425 ND			800 ND				6800 ND
<b>METALS (mg/kg)</b>													
Antimony	10.8 ND	6.1 ND	5 ND	5.4 ND	7.6	10.8 ND	5.9	169	20.3 ND	78.3	43	12.7	17.5 ND
Arsenic	10.8	7.8	1.2 B	2.3	7.1	14.2	6.4	88.3	21.9	24.3	54.5	21.4	2.1 B
Beryllium	0.93 ND	0.78	0.43 ND	0.46 ND	0.62 B	0.93 ND	1.8	4.7 ND	1.7 ND	1.5	2.7	0.44 ND	1.7 B
Cadmium	1.1 ND	0.82 ND	0.62 ND	0.65 ND	0.6 ND	1.1 ND	0.54 ND	5.8 B	2.1 ND	1.3	0.59 ND	0.52 ND	1.8 ND
Chromium	22.9	24	8.6	16.3	22.8	16.9	30.6	212	141	127	108	9.2	61.1
Copper	90.5	28.9	1.5 ND	2.8 B	139	130	181	575	920	1000	676	61	32.2
Lead	126	96	3.3	7.5	151	95.9	128	2860	580	2070	729	211	235
Manganese	115					103			372				483
Mercury	0.52	0.27	0.12 ND	0.13 ND	1.3	1.6	0.38	0.38	13.5	4.2	5.1	0.15	0.21
Nickel	13.1	5.5 B	4.2 ND	4.5 ND	19.8	20.4	27.6	149	25.2	59.5	224	10.3	28.3
Silver	2 ND	1.1 ND	0.92 ND	0.99 ND	1.1 ND	2 ND	0.98 ND	10 ND	3.7 ND	1 ND	1.1 ND	0.84 ND	3.2 ND
Vanadium	58					261			212				123
Zinc	222	128	14.5	19.8	409	213	230	8880	1740	1470	2160	380	100
<b>PESTICIDES/PCBs (ug/kg)</b>													
Dieldrin	4.3 ND					0.38 JP			4.5 JP				6.9 ND
4,4'-DDE	4.3 ND					10			24 P				6.9 ND
4,4'-DDT	4.3 ND					10 P			3 JP				1 JP
Arochlor-1254	43 ND	140 ND	24 ND	25 ND	5500 ND	42 ND	25 ND	260 ND	80 ND	27 ND	100	240 ND	68 ND
Arochlor-1260	43 ND	140 ND	24 ND	25 ND	5500 ND	42 ND	120	8800	80 ND	27 ND	320	240 ND	69 ND
TOTAL PCBs (ug/kg)	0	0	0	0	0	0	120	8800	0	0	480	0	0

## DATA REPORTING QUALIFIERS FOR ORGANICS

- VALUE - If the result is a value greater than or equal to the Contract Required Quantitation Limit (CRQL), report the value.
  
- ND or U - Indicates analyte was analyzed for but not detected.
  
- J - Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the sample quantitation limit but greater than zero.
  
- N - Indicates presumptive evidence of a compound. This flag is only used for tentatively identified compounds.
  
- P - This flag is used for a pesticide/Aroclor target analyte when there is greater than 25% difference for detected concentrations between the two GC columns. The lower of the two values is reported on Form I and flagged with a "P".
  
- C - This flag applies to pesticide results where the identification has been confirmed by GC/MS.
  
- B - This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action. The results have been flagged with this qualifier even if the analyte was found in the associated blank at acceptable levels (i.e. less than the CRQL).
  
- E - This flag identifies compounds whose concentrations exceed the calibration range of the GC/MS instrument for the specific analysis.
  
- D - This flag identifies all compounds identified in an analysis at a secondary dilution factor.
  
- X - Other specific flags and footnotes required to properly define the results.
  
- Y - The "Y" flag is used to denote pesticide/PCB compounds that could not be confirmed by GC/MS. The results from the GC/MS confirmation are included in the sample data package.

## DATA REPORTING QUALIFIERS FOR INORGANICS

### C (Concentration) Qualifiers:

- B - The reported value was obtained from a reading that was less than the Contract Required Detection Limit (CRDL) but greater than or equal to the Instrument Detection Limit (IDL).
- ND or U - Indicates analyte was analyzed for but not detected.

### Q Qualifier:

- E - The reported value is estimated because of the presence of interference.
- M - Duplicate injection precision not met.
- N - Spiked sample recovery not within control limits.
- A or S - The reported value was determined by the Method of Standard Additions (MSA).
- W - Post-digestion spike for Furnace AA analysis is out of control limits (85-115%), while sample absorbance is less than 50% of spike absorbance.
- \* - Duplicate analysis not within control limits.
- + - Correlation coefficient for the MSA is less than 0.995.

### M (Method) Qualifier:

- "P" - for ICP
- "A" - for Flame AA
- "F" - for Furnace AA
- "PM" - for ICP when Microwave Digestion is used
- "AM" - for Flame AA when Microwave Digestion is used
- "FM" - for Furnace AA when Microwave Digestion is used
- "CV" - for Manual Cold Vapor AA
- "AV" - for Automated Cold Vapor AA
- "CA" - for Midi-Distillation Spectrophotometric
- "AS" - for Semi-Automated Spectrophotometric
- "C" - for Manual Spectrophotometric
- "T" - for Titrimetric
- " " - where no data has been entered
- "NR" - if the analyte is not required to be analyzed.

South Carolina Aquarium Site  
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UPLAND SOILS - HORIZON C SOIL SAMPLING RESULTS

TABLE 3-4

SAMPLE NO.	B01-27	B01-52	B02-22 *	B02-32	B03-22 *	B03-72 *	B04-22 *	B04-47	B04D47	B05-42 *	B05-52	B05D52
<b>SEMI-VOLATILES (ug/kg)</b>												
<b>Polynuclear Aromatic</b>												
<b>Hydrocarbons</b>												
Naphthalene	0.87 JB	0.9 JB	480	3.8	170	53	6.4 B	8.7 JB	18 JB	500 ND	4.1 ND	5.5
Acenaphthylene	1 JB	4 ND	30 J	3.8	24 J	4.8 ND	0.15 JB	20 ND	2.5 JB	500 ND	3.9 ND	3.8 ND
Acenaphthene	4 ND	3.5 ND	2400	42	2400	70	5.9	12 J	24	500 ND	2 J	3.4 ND
Fluorene	81 B	25 B	3100	73	82 ND	8.1 ND	7.4 B	48 B	83 B	500 ND	8.8 ND	8.4 ND
Phenanthrene	46	81	14000	2.2 ND	2800	200	30	120	140	500 ND	17	8.7
Anthracene	180	220	4700	180	1700	88	34	280	400	500 ND	15	2 ND
Fluoranthene	2.1	2.6	210	76 B	2000	140	26	88	93	500 ND	18 B	5.1 B
Pyrene	2.3	2.7	8200	51 B	1800	130	19	47	83	500 ND	12 B	4.8 B
Benzo(a)anthracene	0.63 J	0.86	53 B	18 B	250	28	5.9	18	19	500 ND	3.2 B	1.8 B
Chrysene	1.9	1.7	2100	10	100	8	5.2	14	24	500 ND	0.82 J	4.3
Benzo(b)fluoranthene	0.29 J	1.7 B	1200	17 B	210	27	4.2	1.5 J	1.4 J	500 ND	2.8	1.2
Benzo(k)fluoranthene	0.5 JB	0.88 J	830	11 B	120 B	18 B	0.54 J	1.2 J	12	500 ND	2.4	1.2
Benzo(a)pyrene	0.87 JB	0.88 JB	740 B	18 B	150	21	5.9	13	16	500 ND	3.5 B	1.8 B
Dibenz(a,h)anthracene	0.32 J	0.22 J	180	1.8 B	17	1 J	0.16 JB	4.8 ND	1.8 JB	500 ND	0.2 J	0.11 J
Indeno(1,2,3-cd)pyrene	0.48 J	0.55 J	590	12	57	8.7	1.1	7.3	8.7	500 ND	2.1	1.1 ND
Benzo(g,h,i)perylene	0.18 J	0.21 J	48	7.8	58	6.1	1.4	0.6 J	12	500 ND	1.7 B	0.88 JB
TOTAL PAHs (ug/kg)	287.18	338.8	38838	523.8	11754	787.8	152.84	843.2	888	0	78.02	35.5
TOTAL Cal/AAs (ug/kg)	4.78	8.38	5883	87.8	884	118.7	23.88	63	81.5	0	14.82	10.41
<b>Acid Extractables/Base Neutrals</b>												
<b>2-Methylnaphthalene</b>												
Carbazole										250 ND		
										250 ND		
<b>METALS (mg/kg)</b>												
Antimony	6.8 ND	6 ND	8.1 ND	5.8 ND	5.8 ND	7.7	5 ND	5.8 ND	5.8 ND	12.8 ND	5.8 ND	5.8 ND
Arsenic	4.2	9.2	10.8	5	4.4	6	3.7	7	4.2	5.7	3.4	2.7
Beryllium	0.78 B	0.78	0.89	0.5 ND	0.48 ND	1.8	0.43 ND	0.51 ND	0.51 ND	1.1 ND	0.5 ND	0.5 ND
Cadmium	0.7 ND	0.61 ND	0.83 ND	0.8 ND	0.57 ND	0.78 ND	0.51 ND	0.81 ND	0.81 ND	1.3 ND	0.8 ND	0.8 ND
Chromium	23.5	15.4	32.5	10	28.1	40.1	14	18.8	11	16.8	21.7	18.3
Copper	3.3 B	2.3 B	8	1.8 ND	13.4	8.2	4.3	6.2	3.8	3.8 ND	4.5	3.8
Lead	3.2	7.2	8.9	3.7	33.8	15.4	11.8	4.1	3.8	4.1	5.8	8.1
Manganese										53.7		
Mercury	0.18 ND	0.14 ND	0.15 ND	0.14 ND	0.13 ND	0.18 ND	0.12 ND	0.14 ND	0.14 ND	0.15 ND	0.14 ND	0.14 ND
Nickel	9.8	4.9 ND	6.7	4.8 ND	5.7	9.3	4.1 ND	5.2 B	4.8 ND	10.4 ND	5 B	4.8 ND
Silver	1.2 ND	1.1 ND	1.1 ND	1.1 ND	1 ND	1.4 ND	0.92 ND	1.1 ND	1.1 ND	2.3 ND	1.1 ND	1.1 ND
Vanadium										18.5		
Zinc	22.1	18.3	30.4	20.8	37	47.7	13.2	25	15.1	20.9	20.4	18.2
<b>PESTICIDES/PCBs (ug/kg)</b>												
<b>Dieldrin</b>												
4,4'-DDE										5 ND		
4,4'-DDT										5 ND		
Arochlor-1254	32 ND	28 ND	150 ND	28 ND	340	35 ND	24 ND	28 ND	28 ND	50 ND	28 ND	28 ND
Arochlor-1260	32 ND	28 ND	150 ND	28 ND	27 ND	35 ND	24 ND	28 ND	28 ND	50 ND	28 ND	28 ND
TOTAL PCBs (ug/kg)	0	0	0	0	340	0	0	0	0	0	0	0

\* Pre-selected sample

South Carolina Aquarium Site  
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UPLAND SOILS - HORIZON C SOIL SAMPLING RESULTS  
TABLE 3-4 (Continued)

SAMPLE NO.	B08-07	B08-42	B07-12	B07-42	B08-12 *	B08-57 *	B08-23 *	B08-53 *	B10-27	B10-37*	B11-27	B11-37
<b>SEMI-VOLATILES (ug/kg)</b>												
<b>Polynuclear Aromatic Hydrocarbons</b>												
Naphthalene	3100 ND	780 ND	12	1.2 J	2.1 J	3.8 ND	3.8 B	11 ND	2.9 JB	8.8 B	7 B	430 ND
Acenaphthylene	3100 ND	780 ND	3.4 ND	3.8 ND	0.73 J	3.7 ND	1.3 J	3 J	1.9 JB	8.3 B	1.5 J	430 ND
Acenaphthene	12000	1300	5	3.4 ND	14	3.8	0.37 JB	9.1 ND	7 JB	44 B	2.5 JB	430 ND
Fluorene	8700	2100	5.6 ND	8.3 ND	14	10	3.5 JB	18 B	39 B	39 B	44 B	430 ND
Phenanthrene	5800	15000	18 B	9.2 B	48	7.7	13	5.8 ND	72	57	71	100 J
Anthracene	3300	14000	26 B	13 B	30	11	16	5.5 ND	180	530	27	430 ND
Fluoranthene	14000	9400 B	22 B	4.4 B	82 B	11 B	7.7	2.8	27	270	23	77 J
Pyrene	8400	5700 B	22	2.8 B	70 B	9 B	5.2	1.1 J	24	180	11	70 J
Benzo(a)anthracene	3400	2200 B	4.8	0.97	26 B	2.8 B	2.1 B	0.34 JB	7.1 B	80 B	4.3	44 J
Chrysene	2900 J	1400	9.5	1.2 ND	46 B	2.8 B	0.95 J	3.2 ND	8.5	9.9	4.8	430 ND
Benzo(b)fluoranthene	3000 JX	1400	4.7	0.88 J	30	3.3	1.8	2.5 ND	5.6	31	0.28 J	430 ND
Benzo(k)fluoranthene	3000 JX	1200	0.11 JB	0.42 JB	19 B	1.8 B	0.32 J	2.5 ND	0.77 J	8.8	2.2	430 ND
Benzo(a)pyrene	1200 J	2100 B	3.7 B	1 B	7.1 B	2.5 B	2.1	2.5 ND	8.8	53	4.5 B	430 ND
Dibenz(a,h)anthracene	3100 ND	210	0.84 ND	0.07 J	2.7	0.38 J	0.14 J	2.5 ND	0.33 J	0.84 ND	1 ND	430 ND
Indeno(1,2,3-cd)pyrene	3100 ND	820	0.86 ND	1.1 ND	11	1 ND	8.8	2.8 ND	5 J	270	2.5	430 ND
Benzo(g,h,i)perylene	3100 ND	1100 B	2.4	1.5	14	1.2	0.21 J	2.8 ND	3.8 J	7.1	1.2	430 ND
TOTAL PAHs (ug/kg)	63700	57730	128.21	35.24	414.03	87.411	84.38	25.34	381.6	1582.8	208.88	281
TOTAL Cat'Als (ug/kg)	13600	8130	22.81	3.14	141.8	13.711	14.21	0.34	33.8	430.7	18.88	44
<b>Acid Extractables/Base Neutrals</b>												
2-Methylnaphthalene	880 J											430 ND
Carbazole	3100 ND											430 ND
<b>METALS (mg/kg)</b>												
Antimony	10 ND	5.7 ND	6 ND	5.7 ND	5.4 ND	5.5 ND	5.5 ND	7.7 ND	8.4 ND	5.8 ND	8.1 ND	11.1 ND
Arsenic	2.4 B	2.1	3.6	2.7	1.8	4.7	2.9	8.8	8.8	2	12.6	2 B
Beryllium	0.88 ND	0.49 ND	0.43 ND	0.49 ND	0.47 ND	0.51 B	0.47 ND	1.7	0.97	0.48 ND	0.78	0.85 ND
Cadmium	1 ND	0.59 ND	0.52 ND	0.58 ND	0.58 ND	0.57 ND	0.56 ND	0.79 ND	0.65 ND	0.58 ND	0.63 ND	1.1 ND
Chromium	17.3	8.9	13.7	4.3	10.3	19.5	14.1	60.4	18.1	8.3	34.3	4
Copper	7.1	1.7 ND	1.8 B	1.7 ND	1.6 ND	1.7 ND	3.1 B	8.2	3.7 B	1.7 ND	6.4	5.8 B
Lead	10.8	2.4	15.8	2.3	5.8	4.7	5.8	9.5	8.1	1.7	10.1	1.7
Manganese	23.8											20.7
Mercury	0.12 ND	0.14 ND	0.12 ND	0.14 ND	0.13 ND	0.13 ND	0.13 ND	0.18 ND	0.15 ND	0.13 ND	0.15 ND	0.13 ND
Nickel	17.9	4.7 ND	4.2 ND	4.7 ND	4.5 ND	4.6 ND	4.5 ND	13.1	5.3 ND	4.7 ND	10.5	9.2 ND
Silver	1.8 ND	1 ND	0.93 ND	1 ND	1 ND	1 ND	1 ND	1.4 ND	1.2 ND	1 ND	1.1 ND	2 ND
Vanadium	80.3											3.3 B
Zinc	31.5	8.4	12.7	9	8.2	20.3	11.8	51.3	20.9	8.8	33.2	8.8
<b>PESTICIDES/PCBs (ug/kg)</b>												
Dieldrin	3.8 ND											4.3 ND
4,4'-DDE	4.9 P											4.3 ND
4,4'-DDT	0.37 JP											0.17 JP
Aroclor-1254	38 ND	27 ND	24 ND	27 ND	130 ND	28 ND	28 ND	38 ND	38 ND	27 ND	28 ND	43 ND
Aroclor-1260	38 ND	27 ND	24 ND	27 ND	130 ND	28 ND	28 ND	38 ND	38 ND	27 ND	28 ND	43 ND
TOTAL PCBs (ug/kg)	0	0	0	0	0	0	0	0	0	0	0	0

\* Pre-selected sample

South Carolina Aquarium Site  
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UPLAND SOILS - HORIZON C SOIL SAMPLING RESULTS  
TABLE 3-4 (Continued)

SAMPLE NO.	B11-62	B11D62	B12-20 *	B12-40	B13-16	B13-46 *	B14-12 *	B14-42 *	B16-12	B16-72 *	B18-47 *	B18-62
<b>SEMI-VOLATILES (ug/kg)</b>												
<b>Polynuclear Aromatic Hydrocarbons</b>												
Naphthalene	3.4 JB	9 B	400 ND	21 ND	0.77 JB	5.1 B	3.4 ND	19 ND	11	28 ND	270 J	14000
Acenaphthylene	4.9 ND	1.4 J	400 ND	20 ND	3.3 ND	0.21 JB	3.3 ND	18 ND	3.4 ND	25 ND	440 ND	4.5 ND
Acenaphthene	0.18 JB	4.6 B	43 J	2.8 J	0.52 J	4.9	13	140	52	23 ND	1400	73
Fluorene	42 B	43 B	400 ND	34 ND	5.3 JB	21 B	5.6 ND	120 B	3.9 J	32 J	800	72
Phenanthrene	130	100	400 ND	32	1.8 ND	8.4	21	93	4.5 B	15 ND	2100	78
Anthracene	300	300	400 ND	81	1.7 ND	140	4.2	160	7.8 B	85	340 J	130
Fluoranthene	11	15	400 ND	10	3.1	34	28	87	7.9 B	8.4 ND	1700	2.1
Pyrene	6.7	7.7	400 ND	8.3	1.9	23	28	88	8.2 B	4.2 J	1500	8.8
Benzo(a)anthracene	1.2	2.9	400 ND	3.5 J	0.81 J	7.4	12	25	3.3	0.88 J	540	22 B
Chrysene	1.5 ND	3.1	400 ND	6.5 ND	1 ND	15	13	16	6.9	5.9 J	250 J	170
Benzo(b)fluoranthene	0.32 J	0.42 J	400 ND	5.1 ND	0.39 J	5.9	5.3	23	4.3	1.9 J	250 JX	12
Benzo(k)fluoranthene	0.66 J	1.7	400 ND	3.3 JB	0.44 J	0.75 J	8.1	13	2.3 B	0.2 J	250 JX	2.9
Benzo(a)pyrene	1.1 JB	3 B	400 ND	3.8 JB	0.57 J	7.7	7.2	22	3.7 B	6.4 ND	110 J	0.16 JB
Dibenz(a,h)anthracene	1.2 ND	1.1 ND	400 ND	5.1 ND	0.81 ND	0.11 JB	1.1	3.3 J	1.5	8.4 ND	440 ND	1.5
Indeno(1,2,3-cd)pyrene	0.69 J	1.9	400 ND	22	0.82 ND	4.5	3.4	5.7	1.8	7.2 ND	440 ND	1.3 ND
Benzo(g,h,i)perylene	0.23 J	0.39 J	400 ND	2.1 J	0.51 J	0.71 J	2.3	8.4	2.9	7.2 ND	440 ND	6.0
TOTAL PAHs (ug/kg)	487.38	404.01	43	108.0	14.11	270.88	148.0	815.4	122	128.88	8510	14570.2
TOTAL Cal'PAHs (ug/kg)	3.87	12.92	0	32.8	2.01	41.38	48.1	108	23.8	8.88	1400	208.60
<b>Acid Extractables/Base Neutrals</b>												
2-Methylnaphthalene			400 ND								390 J	
Carbazole			400 ND								44 ND	
<b>METALS (mg/kg)</b>												
Antimony	7.4 ND	6.6 ND	10.1 ND	6.2 ND	4.9 ND	5.9 ND	5.1 ND	5.6 ND	5.1 ND	7.7 ND	11.2 ND	6.7 ND
Arsenic	21.3	14.5	1.9 B	5.7	2.4	4.2	2.5	3.9	2.8	6.2	3.6	8.9
Beryllium	1	0.78 B	0.87 ND	0.84 B	0.42 ND	0.51 ND	0.43 ND	0.48 ND	0.44 ND	1.3	0.87 ND	0.74 B
Cadmium	0.78 ND	0.69 ND	1 ND	0.63 ND	0.5 ND	0.81 ND	0.52 ND	0.57 ND	0.52 ND	0.79 ND	1.2 ND	0.89 ND
Chromium	48.8	35.6	10.5	10.6	8.4	15.2	8.8	9.7	7.4	39.9	15.4	34.8
Copper	7.4	5	5.8 B	1.9 ND	2.8 B	3.4 B	1.5 ND	1.7 ND	1.5 ND	9	3.7 B	5.1
Lead	13.9	11.4	11.8	5	14.8	5.3	5.5	3.7	13.5	17.8	7.8	12.2
Manganese			35.8								53.2	
Mercury	0.18 ND	0.16 ND	0.12 ND	0.15 ND	0.12 ND	0.14 ND	0.12 ND	0.13 ND	0.12 ND	0.18 ND	0.13 ND	0.18 ND
Nickel	10.5	7.2	8.4 ND	5.1 ND	4 ND	5.5 B	4.2 ND	4.8 ND	4.2 ND	14	5 B	8.4
Silver	1.4 ND	1.2 ND	1.9 ND	1.1 ND	0.89 ND	1.1 ND	0.93 ND	1 ND	0.93 ND	1.4 ND	2.1 ND	1.2 ND
Vanadium			13								23.9	
Zinc	43.7	34.2	18.9	14.1	9.4	22.4	9	9.8	8.3	51.3	23.2	31.1
<b>PESTICIDES/PCBs (ug/kg)</b>												
Dieldrin			4 ND								0.25 JP	
4,4'-DDE			4 ND								0.17 JP	
4,4'-DDT			4 ND								4.4 ND	
Aroclor-1254	35 ND	32 ND	40 ND	28 ND	23 ND	28 ND	24 ND	27 ND	24 ND	38 ND	44 ND	32 ND
Aroclor-1260	35 ND	32 ND	40 ND	28 ND	23 ND	28 ND	24 ND	27 ND	24 ND	38 ND	44 ND	32 ND
TOTAL PCBs (ug/kg)	0	0	0	0	0	0	0	0	0	0	0	0

\* Pre-selected sample

South Carolina Aquarium Site  
Charleston, South Carolina  
UPLAND SOILS - HORIZON C SOIL SAMPLING RESULTS  
TABLE 3-4 (Continued)

SAMPLE NO.	B16-72	B17-40	B17-56	B18-20	B18-40	B18-60 *	B18-57	B20-62 *	B21-37	B21-82 *	B22-10	B22-35	B23-12
<b>SEMI-VOLATILES (ug/kg)</b>													
<b>Polynuclear Aromatic Hydrocarbons</b>													
Naphthalene	23	56 B	12 JB	5700	440 ND	17	3.8 ND	23000	1400	13 J	2000 JB	520 ND	780 B
Acenaphthylene	4.8 ND	42 ND	27 JB	570	440 ND	1.7 J	0.88 JB	240 ND	750 ND	14 ND	3100 ND	520 ND	130 JB
Acenaphthene	68	300	57	1200	440 ND	11	3.4 ND	1800	680	12 ND	2800 ND	520 ND	570 B
Fluorene	57	180 B	83 B	170 ND	440 ND	99	15 B	400 ND	1300 ND	24 ND	73000 B	520 ND	3800 B
Phenanthrene	230	180	370	1700	440 ND	150	5.6	430	1800	8 ND	38000	200 J	18000
Anthracene	98	3000	330	480	440 ND	510	2 ND	130 ND	7000	57	1700 ND	520 ND	9200
Fluoranthene	11	1500	220	660	440 ND	35	3.9	59 ND	5800 B	7.8 B	78000	180 J	18000 B
Pyrene	24	1000 B	180 B	500	440 ND	17	3.2	87 ND	3300 B	7.9 B	12000	180 J	12000 B
Benzofluoranthene	1.3 B	450 B	58 B	190	440 ND	5.4	1 B	5.1 J	1300 B	2.1 JB	1300 B	94 J	3800 B
Chrysene	93	180	180	540	440 ND	30	4.5	75 ND	240 J	8.1	290000	96 J	20000
Benzobenzofluoranthene	49	200	47	140	440 ND	5.6	0.83 J	59 ND	1100	0.92 J	800	120 JX	720
Benzokjfluoranthene	11	250 B	34 B	100 B	440 ND	2.8 B	0.82 J	5.7 J	780	2.3 J	870	120 JX	510
Benzofluoranthene	1.4 B	440 B	60 B	180	440 ND	4	1	4.4 J	1400 B	2.1 JB	410 J	62 J	4400
Dibenz(a,h)anthracene	5.9	77	12	14 J	440 ND	1 ND	0.85 ND	59 ND	42 J	3.5 ND	770 ND	520 ND	120
Indeno(1,2,3-cd)pyrene	250	280	311	71	440 ND	2.1	1.1 ND	87 ND	110	4 ND	870 ND	520 ND	2900
Benzofluoranthene	0.61 J	170	20	42	440 ND	3	1.8	87 ND	800 B	1.5 JB	2700	520 ND	2800 B
TOTAL PAHs (ug/kg)	821.21	821.2	1700	12007	0	803.4	37.03	25246.2	20062	102.72	480080	1042	88510
TOTAL CalPAHs (ug/kg)	411.8	1887	430	1216	0	48.7	7.76	15.2	50172	15.62	283380	482	32450
<b>Acid Extractables/Base Neutrals</b>													
2-Methylnaphthalene					440 ND							520 ND	
Carbazole					440 ND							520 ND	
<b>METALS (mg/kg)</b>													
Antimony	7.5 ND	6.4 ND	5.6 ND	7.8 ND	11.4 ND	6.1 ND	5.7 ND	7.1 ND	5.7 ND	5.9 ND	6.8	13.3 ND	43.2
Arsenic	9.2	5.4	10.2	13	3.4	4.3	3.2	2.1	2.2	6.3	12.8	6	25.8
Beryllium	1.3	0.55 ND	0.6 B	0.83 B	0.88 ND	0.53 ND	0.49 ND	0.97	0.49 ND	0.51 ND	0.38 ND	1.1 ND	0.49 ND
Cadmium	0.77 ND	0.68 ND	0.57 ND	0.8 ND	1.2 ND	0.63 ND	0.68 ND	0.73 ND	0.59 ND	0.6 ND	0.43 ND	1.4 ND	6.5
Chromium	62.6	17.9	20.1	27.7	19.7	2.8	23.3	39.7	7.8	48.5	20.2	11.3	15
Copper	9.2	3.9	3.4	5.4	3.4 ND	1.9 ND	3.8	5.1	1.7 B	10.8	131	7.8 B	388
Lead	6.3	6.4	8.7	13.9	2.7	4.8	6.5	21.2	2.4	1.4	142	2	744
Manganese					85.2							50.4	
Mercury	0.18 ND	0.15 ND	0.13 ND	0.19 ND	0.14 ND	0.15 ND	0.14 ND	0.17 ND	0.14 ND	0.14 ND	0.22	0.16 ND	0.48
Nickel	12.3	5.3 ND	6.5	7.5	9.4 ND	5.1 ND	4.7 ND	9.1	4.7 ND	19.2	23.9	11 ND	13.4
Silver	1.4 ND	1.2 ND	1 ND	1.4 ND	2.1 ND	1.1 ND	1 ND	1.3 ND	1 ND	1.1 ND	0.77 ND	2.4 ND	1 ND
Vanadium					20.8							15 B	
Zinc	64.9	21.8	19.6	28.8	18.5	5.7	22.8	44.9	7.6	38.1	79.2	22.2	3150
<b>PESTICIDES/PCBs (ug/kg)</b>													
Dieldrin					4.5 ND							5.2 ND	
4,4'-DDE					4.5 ND							5.2 ND	
4,4'-DDT					4.5 ND							5.2 ND	
Arochlor-1264	36 ND	30 ND	27 ND	37 ND	46 ND	29 ND	27 ND	33 ND	27 ND	28 ND	20 ND	52 ND	27 ND
Arochlor-1280	36 ND	30 ND	27 ND	37 ND	46 ND	29 ND	27 ND	33 ND	27 ND	28 ND	7.4 J	52 ND	27 ND
TOTAL PCBs (ug/kg)	0	0	0	0	0	0	0	0	0	0	7.4	0	0

\* Pre-selected sample

South Carolina Aquarium Site  
Charleston, South Carolina  
UPLAND SOILS - HORIZON C SOIL SAMPLING RESULTS  
TABLE 3-4 (Continued)

SAMPLE NO.	B23-32	B23-57	B24-10	B24-40 *	B25-15	B26-10 *	B26-40	B26D40	B26-65*	B27-57	B27-67*	B28-52
<b>SEMI-VOLATILES (ug/kg)</b>												
<b>Hydrocarbons</b>												
Naphthalene	1.7 JB	470 ND	3.8 ND	4.3 ND	5.3 JB	1500	14	2.3 J	52 ND	480 ND	2.3 J	27 ND
Acenaphthylene	2.8 JB	470 ND	0.9 J	0.28 JB	1.9 JB	200 J	4 ND	3.7 ND	50 ND	480 ND	4.9 ND	28 ND
Acenaphthene	4.6 J	470 ND	1.6 JB	18 B	14	3300	47	6.6	46 ND	480 ND	1.6 J	12 J
Fluorene	44 B	470 ND	12 B	58 B	60 B	2300	68	28	84 ND	480 ND	8.8	81
Phenanthrene	23	470 ND	45	120	180	8700	150	2.1 ND	75	480 ND	2.8 ND	15 ND
Anthracene	41	470 ND	220	230	88	2800	60	2 ND	27 ND	480 ND	2.8 ND	14 ND
Fluoranthene	17	470 ND	140	89	81	5800	110	15	82	480 ND	5.1	6.8
Pyrene	14	470 ND	110	62	84	8300	110	15	68	480 ND	3	7.4 ND
Benzo(a)anthracene	4.8	470 ND	45 B	21 B	23	3400	27	3.9	20	480 ND	0.78 J	3.1 JB
Chrysene	76	470 ND	45	19	23	2500	22	1.2	16 ND	480 ND	3.3	8.3 ND
Benzo(b)fluoranthene	4 J	470 ND	51	18	24	3400 X	29	5.2	12 J	480 ND	1.7	6.5 ND
Benzo(k)fluoranthene	3.8 JB	470 ND	5.2	2.1	18 B	3400 X	18 B	2.4 B	1.5 JB	480 ND	0.67 JB	6.5 ND
Benzo(a)pyrene	5.7 B	470 ND	48	22	23 B	2200	28	2.7	15	480 ND	0.72 JB	140 B
Dibenz(a,h)anthracene	4.4 ND	470 ND	5.3	2.2	2.2 J	340 J	2	0.11 J	13 ND	480 ND	1.2 ND	6.5 ND
Indeno(1,2,3-cd)pyrene	4.3 J	470 ND	300	15	16	1100 J	12	1.1 ND	14 ND	480 ND	1.4 ND	7.4 ND
Benzo(g,h,i)perylene	1.7 J	470 ND	21	11	18	830 J	11	0.78 J	14 ND	480 ND	0.83 J	7.4 ND
TOTAL PAHs (ug/kg)	247.3	0	1047.8	858.58	819.4	48170	708	82.07	241.5	0	28.3	222.9
TOTAL CaPAHs (ug/kg)	87.8	0	407.5	100.3	129.2	10340	130	15.51	48.5	0	7.17	143.1
<b>Acid Extractables/Base Neutrals</b>												
2-Methylnaphthalene		470 ND					1400			480 ND		
Carbazole		470 ND					580 J			480 ND		
<b>METALS (mg/kg)</b>												
Antimony	5.3 ND	12 ND	5.2 ND	8.3 ND	5.5 ND	10.9 ND	8 ND	5.8 ND	7.7	12.2 ND	7.3 ND	8 ND
Arsenic	3.8	3.8	1.7	4.8	1.9	4	3.2	3.3	12.2	7.3	17.6	20.9
Beryllium	0.48 ND	1 ND	0.68 B	0.85 B	0.53 B	0.94 ND	0.51 ND	0.48 ND	1.3	1.1 ND	0.85 B	1.1
Cadmium	0.55 ND	1.2 ND	0.54 ND	0.84 ND	0.56 ND	1.1 ND	0.81 ND	0.58 ND	0.78 ND	1.3 ND	0.75 ND	0.82 ND
Chromium	8.8	18	8	11.1	12.8	17.8	7	10	42	31.8	20.9	53.4
Copper	1.8 ND	4.8 B	1.8 ND	1.9 ND	3.2 B	5.9 B	1.8 ND	2.7 B	8.5	5.8 B	4.9	8.5
Lead	4.1	3.7	10.1	3.1	11	15.8	1.9	2.2	13.4	8.9	12.8	12.9
Manganese		80.7				28.9				122		
Mercury	0.13 ND	0.14 ND	0.12 ND	0.15 ND	0.13 ND	0.13 ND	0.14 ND	0.13 ND	0.18 ND	0.15 ND	0.17 ND	0.18 ND
Nickel	4.4 ND	9.9 ND	4.3 ND	5.2 ND	4.8 ND	10.1 B	4.9 ND	4.7 ND	11.2	13.3	9.2	14.8
Silver	0.88 ND	2.2 ND	0.86 ND	1.2 ND	1 ND	2 ND	1.1 ND	1 ND	1.4 ND	2.2 ND	1.3 ND	1.5 ND
Vanadium		12.4 B				22.6				28.6		
Zinc	11.3	28	10.8	13	18.9	18.8	10.2	11.3	45.8	28.2	44.6	48
<b>PESTICIDES/PCBs (ug/kg)</b>												
Dieldrin		4.7 ND				7.4 P				4.8 ND		
4,4'-DDE		4.7 ND				4.3 ND				4.8 ND		
4,4'-DDT		4.7 ND				4.3 ND				4.8 ND		
Arochlor-1264	25 ND	47 ND	25 ND	30 ND	28 ND	43 ND	28 ND	27 ND	38 ND	48 ND	35 ND	37 ND
Arochlor-1260	25 ND	47 ND	25 ND	30 ND	28 ND	43 ND	28 ND	27 ND	38 ND	48 ND	35 ND	37 ND
TOTAL PCBs (ug/kg)	0	0	0	0	0	0	0	0	0	0	0	0

\* Pre-selected sample

South Carolina Aquarium Site  
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UPLAND SOILS - HORIZON C SOIL SAMPLING RESULTS  
TABLE 3-4 (Continued)

SAMPLE NO.	B28-67 *	B28D67 *	B28-06	B28-10 *	B30-62 *	B30-77 *	B31-82 *	B31D82*	B32-70*	B33-66 *	B33-76 *	B34-22 *
<b>SEMI-VOLATILES (ug/kg)</b>												
<b>Hydrocarbons</b>												
Naphthalene	690 J	310 J	1100	430 ND	480 ND	1.6 JB	460 ND	460 ND	2.6 JB	30 ND	6.2 ND	2.9 J
Acenaphthylene	4800 ND	480 ND	750 ND	430 ND	480 ND	4.1 ND	460 ND	460 ND	0.88 JB	29 ND	6 ND	5.2 J
Acenaphthene	13000	140 J	870 ND	430 ND	480 ND	1.2 J	460 ND	460 ND	4.8 ND	28 ND	4.5 ND	11 J
Fluorene	12000	58 J	1700	430 ND	480 ND	3.1 JB	460 ND	460 ND	12	49 ND	19	110
Phenanthrene	33000	100 J	880 B	430 ND	480 ND	4.6	460 ND	460 ND	4.3	22	2.9 ND	48
Anthracene	10000	480 ND	400 ND	430 ND	480 ND	9.1	460 ND	460 ND	2.8 ND	18 ND	2.7 ND	180
Fluoranthene	26000	58 J	480	430 ND	480 ND	18	460 ND	460 ND	3.6	11	1.3 ND	44
Pyrene	18000	60 J	1600	430 ND	480 ND	11	460 ND	460 ND	2.4	6.4 J	1.4 ND	8.2 J
Benzo(a)anthracene	8000	480 ND	140 J	430 ND	480 ND	0.78 J	460 ND	460 ND	0.72 JB	0.83 J	1.1 ND	4.9 J
Chrysene	8400	480 ND	730	430 ND	480 ND	4.1	460 ND	460 ND	17	28	1.8 ND	1200
Benzo(b)fluoranthene	6000 X	480 ND	130 J	430 ND	480 ND	2.2	460 ND	460 ND	6.2	7.3 ND	2	7.3 J
Benzo(k)fluoranthene	6000 X	480 ND	62 JB	430 ND	480 ND	0.68 J	460 ND	460 ND	1.4 B	0.86 J	0.66 J	5.9 J
Benzo(a)pyrene	3100 J	480 ND	120 JB	430 ND	480 ND	1.1	460 ND	460 ND	1 JB	1.8 JB	0.1 JB	6.6 J
Dibenz(a,h)anthracene	4800 ND	480 ND	190 ND	430 ND	480 ND	1 ND	460 ND	460 ND	1.3 ND	7.3 ND	1.3 ND	2.7 J
Indeno(1,2,3-cd)pyrene	4800 ND	480 ND	210 ND	430 ND	480 ND	0.36 J	460 ND	460 ND	1.6 ND	8.3 ND	1.4 ND	14 ND
Benzo(g,h,i)perylene	4800 ND	480 ND	73 J	430 ND	480 ND	0.41 J	460 ND	460 ND	1.8	1.8 J	0.82 J	21
TOTAL PAHs (ug/kg)	144080	714	8866	0	0	58.02	0	0	62.6	72.48	22.27	1838.8
TOTAL CoPAHs (ug/kg)	31600	0	1172	0	0	9.11	0	0	26.32	31.28	2.86	1228.3
<b>Acid Extractables/Base Neutrals</b>												
2-Methylnaphthalene	3800 J	480 ND		81 J	480 ND		460 ND	460 ND				
Carbazole	1600 J	120 J		430 ND	480 ND		460 ND	460 ND				
<b>METALS (mg/kg)</b>												
Antimony	11.8 ND	12.2 ND	313	10.9 ND	12.3 ND	6.1	11.5 ND	11.8 ND	7.8 ND	4.5 ND	7.6 ND	7.5 ND
Arsenic	4.1	3.8	38.8	1.4 B	7	8.4	4.6	4.8	7	1.1	8.8	17.2
Beryllium	0.89 ND	1 ND	1.3	0.83 ND	1.8	0.62 ND	0.99 ND	1 ND	1.3	0.48 B	1.3	1.1
Cadmium	1.2 ND	1.3 ND	8	1.1 ND	1.3 ND	0.82 ND	1.2 ND	1.2 ND	0.8 ND	0.48 ND	0.78 ND	0.77 ND
Chromium	30.8	23.1	314	20.1	48.6	28.3	46.4	44.6	47.8	8	32.4	34.4
Copper	7	8.7 B	1280	6.7	3.7 ND	4.8	11.6	11.8	8.4	2.8 B	8.9	8.9
Lead	4.7	4.8	1060	6.1	14.4	4	0.65 ND	0.67 B	12.1	1.7	18	16.6
Manganese	102	84.1		18.4	288		128	73				
Mercury	0.14 ND	0.16 ND	33.7	0.13 ND	0.16 ND	0.14 ND	0.14 ND	0.14 ND	0.18 ND	0.11 ND	0.18 ND	0.18 ND
Nickel	18.1	18.7	126	8 ND	16	6	18.9	17.9	15.2	6.2	11.8	8.2 ND
Silver	2.1 ND	2.2 ND	1 B	2 ND	2.3 ND	1.1 ND	2.1 ND	2.1 ND	1.4 ND	0.82 ND	1.4 ND	1.4 ND
Vanadium	28.7	20.4		18.3	48.2		23.8	23.6				
Zinc	31.1	28.9	8420	21.3	65.8	27.7	41.4	44.4	62.2	10	48.4	37.2
<b>PESTICIDES/PCBs (ug/kg)</b>												
Dieldrin	0.13 J	4.8 ND		4.3 ND	4.8 ND		4.6 ND	4.6 ND				
4,4'-DDE	4.8 ND	4.8 ND		4.3 ND	0.88 JBP		4.6 ND	4.6 ND				
4,4'-DDT	4.8 ND	4.8 ND		4.3 ND	0.82 JP		4.6 ND	4.6 ND				
Arochlor-1254	48 ND	48 ND	28 ND	43 ND	48 ND	28 ND	46 ND	46 ND	37 ND	21 ND	38 ND	36 ND
Arochlor-1260	48 ND	48 ND	460 P	43 ND	48 ND	28 ND	46 ND	46 ND	16 JP	21 ND	38 ND	36 ND
TOTAL PCBs (ug/kg)	0	0	460	0	0	0	0	0	16	0	0	0

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UPLAND SOILS - HORIZON C SOIL SAMPLING RESULTS  
TABLE 3-4 (Continued)

SAMPLE NO.	B36-10	B36-63 *	B38-12 *	B38-64	B38-22	B38-67	B38-17	B38-67	B40-76 *	B40D76*	B40-80*	B41-10	B41-20
<b>SEMI-VOLATILES (ug/kg)</b>													
<b>Hydrocarbons</b>													
Naphthalene	2400	11000 D	340 J	93 J	0.73 JB	480 ND	70 J	0.88 J	2.2 JB	7.8 B	8.4 B	430 ND	47
Acenaphthylene	550 ND	1800 ND	270 J	570 ND	1.7 JB	480 ND	400 ND	4.2 ND	5.8	12	11	430 ND	13 J
Acenaphthene	2500	3100 D	3800	570 ND	3.1 ND	480 ND	400 J	0.2 J	1.4 JB	3.2 JB	2.2 JB	430 ND	22 J
Fluorene	4800	2400 D	3700	570 ND	57 B	480 ND	350 J	26	37	48	28	430 ND	87 J
Phenanthrene	940	8200 D	18000	570 ND	2 ND	480 ND	1200	6	38	110	86	430 ND	240
Anthracene	4800	990 DJ	3700	570 ND	1.8 ND	480 ND	240 J	4.1	40	95	86	430 ND	18 J
Fluoranthene	4300	3000 D	26000 B	84 J	13	480 ND	510	4.4	15	41	28	200 J	130
Pyrene	3300	2700 D	21000 B	58 J	13	480 ND	480	2.3	23	45	33	180 J	180
Benzo(a)anthracene	1200	920 DJ	8500 B	570 ND	3.8 B	480 ND	170 J	0.89 J	6.4	19	14	74 J	83
Chrysene	3700	520 DJ	5700 B	570 ND	8.7	480 ND	140 J	4.5	8.8 B	14 B	11 B	75 J	4500
Benzo(b)fluoranthene	150	890 DJX	7200	570 ND	4.2	480 ND	150 JX	0.87 J	8.4	15	9.8	53 JX	87
Benzo(k)fluoranthene	850	880 DJX	5200 B	570 ND	3	480 ND	150 JX	0.52 J	3.8 B	9.8 B	8.4 B	53 JX	34
Benzo(a)pyrene	1100 B	310 DJ	8400 B	570 ND	5.1 B	480 ND	97 J	0.86 J	6.3	19	0.58 J	430 ND	84
Dibenzo(a,h)anthracene	43 J	1800 ND	1300	570 ND	0.88 ND	480 ND	400 ND	1 ND	0.81 J	1.9	4.5	430 ND	9.3 JB
Indeno(1,2,3-cd)pyrene	870	1800 ND	4700	570 ND	5.3	480 ND	400 ND	1.2 ND	3.3	9.8	7.3	430 ND	12 ND
Benzo(g,h,i)perylene	420	1800 ND	4600	570 ND	2.5	480 ND	400 ND	0.44 J	3	8.8	8.2	430 ND	38
TOTAL PAHs (ug/kg)	30573	32520	118410	218	119.03	0	3957	51.18	188.71	457.2	344.38	845	5470.3
TOTAL C <sub>10</sub> PAHs (ug/kg)	7513	3130	41000	0	31.1	0	707	7.74	33.21	88.5	65.58	256	4737.3
<b>Acid Extractables/Base Neutrals</b>													
2-Methylnaphthalene		1800 D		570 ND		480 ND	160 J					430 ND	
Carbazole		1500 DJ		570 ND		480 ND	400 ND					430 ND	
<b>METALS (mg/kg)</b>													
Antimony	8.1 ND	15.3 ND	6.8 ND	14.7 ND	5.2 ND	12.4 ND	10.4 ND	6.2 ND	5.4 ND	6.8 ND	5.8 ND	11 ND	6.5 ND
Arsenic	14.7	5.8	14.1	6.8	4.4	3.9	7.5	3	5.7	9.1	7.2	1.7 B	8.7
Beryllium	0.95 B	1.3 ND	1	1.8	0.45 ND	1.1 ND	0.89 ND	0.54 ND	0.5 B	1.5	0.59 B	0.95 ND	0.91
Cadmium	0.83 ND	1.8 ND	0.7 ND	1.5 ND	0.53 ND	1.3 ND	1.1 ND	0.84 ND	0.55 ND	0.7 ND	0.58 ND	1.1 ND	0.87 ND
Chromium	31.4	53	37.1	82.9	14	25	9.8	14	18.4	45.8	25.1	8.8	32.1
Copper	44.4	9.2	22.5	10.1	1.8 B	3.8 B	3.1 ND	3.7 B	2.3 B	7.2	3.8	3.3 ND	9.3
Lead	83.2	9.7	48.2	17.5	20	5	4.9	4	8.6	9.8	5.2	1.6	14
Manganese		291		387		84.8	58.3					12.8	
Mercury	0.24	0.18 ND	0.16 ND	0.18 ND	0.12 ND	0.15 ND	0.12 ND	0.15 ND	0.13 ND	0.16 ND	0.13 ND	0.13 ND	0.16 ND
Nickel	12.4	22	12.5	17.9	4.3 ND	10.3 ND	8.6 ND	5.2 ND	4.4 ND	9.4	4.7 ND	9.1 ND	7.3
Silver	1.5 ND	2.8 ND	1.3 ND	2.7 ND	0.96 ND	2.3 ND	1.8 ND	1.1 ND	0.98 ND	1.3 ND	1 ND	2 ND	1.2 ND
Vanadium		52.1		57.4		22.9	13.4					8 B	
Zinc	101	45	58.3	61.8	10	22.4	22.3	17	23.2	48.9	25	15.6	33.3
<b>PESTICIDES/PCBs (ug/kg)</b>													
Dieldrin		5.8 ND		5.8 ND		4.8 ND	4 ND					4.3 ND	
4,4'-DDE		0.66 JP		5.8 ND		4.8 ND	0.21 JP					4.3 ND	
4,4'-DDT		5.9 ND		5.8 ND		4.8 ND	4 ND					4.3 ND	
Aroclor-1254	38 ND	58 ND	180 ND	58 ND	25 ND	48 ND	40 ND	28 ND	26 ND	32 ND	27 ND	43 ND	31 ND
Aroclor-1260	38 ND	58 ND	180 ND	58 ND	25 ND	48 ND	40 ND	28 ND	26 ND	32 ND	27 ND	43 ND	31 ND
TOTAL PCBs (ug/kg)	0	0	0	0	0	0	0	0	0	0	0	0	0

\* Pre-selected sample

South Carolina Aquarium Site  
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UPLAND SOILS - HORIZON C SOIL SAMPLING RESULTS  
TABLE 3-4 (Continued)

SAMPLE NO.	B41-42	B42-16	B43-17	B43-23	B43-67 *	B44-67*	B44-80*	B45-12	B45-67 *	B46-11	B47-04 *	B47-13	B47-40
<b>SEMI-VOLATILES (ug/kg)</b>													
<b>Hydrocarbons</b>													
Naphthalene	44000	3700	48000 B	180000	2200	440 J	3.2 J	11000	620 ND	780 ND	130 J	7.6 J	11
Acenaphthylene	1000	41 J	820 J	3500	690 ND	680 ND	3.8 ND	780 J	620 ND	730 ND	440 ND	18 ND	2.1 J
Acenaphthene	18000	480	14000 B	51000	1000	680 ND	3.5 ND	27000	620 ND	1700	440 ND	1.8 J	16
Fluorene	18000	110 ND	5800	39000	870	680 ND	6.6 ND	30000	620 ND	1200 ND	440 ND	13 J	42
Phenanthrene	42000	38 ND	60000	180000	2400	680 ND	3.8	8000	620 ND	8200	130 J	78	100
Anthracene	21000	350	24000	98000	730	680 ND	16	29000	620 ND	6200	440 ND	68	41
Fluoranthene	23000	280	19000 B	70000	1400	680 ND	2.3	12000	620 ND	6700 B	200 J	72	70
Pyrene	18000	620	16000 B	70000	1100	680 ND	1.8	3000	620 ND	4700 B	170 J	130	68
Benzo(a)anthracene	6300	82	4400	17000	450 J	680 ND	0.47 J	380 JB	620 ND	1700 B	150 J	33	22
Chrysene	16000	380	630	3200	340 J	680 ND	0.63 J	8800	620 ND	1200	140 J	18	3.8
Benzo(b)fluoranthene	3200	100	1600	6700	340 JX	680 ND	1.8	33000	620 ND	1400	160 J	33	12
Benzo(k)fluoranthene	2000	68	1800 B	8000 B	340 JX	680 ND	0.7 JB	2500	620 ND	840	110 J	8	2.6
Benzo(a)pyrene	2600	1.2 J	2800	11000	150 J	680 ND	0.35 JB	770	620 ND	1400 B	130 J	63	1
Dibenz(a,h)anthracene	280 B	8.1 J	200 ND	740	690 ND	680 ND	0.25 J	1300	620 ND	110 J	440 ND	2.4 J	0.88 J
Indeno(1,2,3-cd)pyrene	760	38	1200	3500	690 ND	680 ND	1.1 ND	61000	620 ND	800	71 J	14	6.7
Benzo(g,h,i)perylene	430	87	1600	2800	690 ND	680 ND	1.1 ND	870	620 ND	680 B	440 ND	6.8	2.9
TOTAL PAHs (ug/kg)	213470	6177.3	191060	723640	11420	440	31.4	230180	0	36610	1411	628.7	400.88
TOTAL CaPAHs (ug/kg)	29040	669.3	12130	49140	1620	0	4.2	107660	0	7460	781	163.4	48.88
<b>Acid Extractables/Base Neutrals</b>													
2-Methylnaphthalene					670	680 ND			620 ND		160 J		
Carbazole					670	680 ND			620 ND		440 ND		
<b>METALS (mg/kg)</b>													
Antimony	5.3 ND	6.1 ND	6.1 ND	6.1 ND	15.1 ND	14.6 ND	6	8.8 ND	15.7 ND	6.6 ND	8.8 ND	4.1 ND	4.6 ND
Arsenic	3	2	12.4	8	9.3 B	11.9 ND	3.2	17.8	6.7	7.8	3.6	4.2	2.8
Beryllium	0.46 ND	0.43 ND	0.69 B	0.63 ND	1.8 B	2	0.6 ND	1.2	2	0.47 ND	0.68 B	0.28 B	0.3 B
Cadmium	0.66 ND	0.62 ND	0.83 ND	0.63 ND	1.6 ND	1.6 ND	0.6 ND	0.9 ND	1.6 ND	0.67 ND	1.2 ND	0.68 ND	0.64 ND
Chromium	12.7	11.8	18	16.9	64	78.6	60.8	31.8	78.4	22.1	13.5	28.6	10
Copper	1.6 ND	3.2	12.7	4.9	9.3	12	8.6	17.3	14.6	60.9	47.2	96	3.9
Lead	3.6	7.7	31.6	10	16.4	13	1.9	30	8.6	36.7	54.7	69.7	4.6
Manganese					289	298			300		66		
Mercury	0.13 ND	0.12 ND	0.16 ND	0.16 ND	0.18 ND	0.17 ND	0.14 ND	0.21 ND	0.19 ND	0.06	0.13 ND	0.2	0.14 ND
Nickel	4.4 ND	4.2 ND	12.3	6.1 ND	18	21.7	23	11.6	28.6	7.6	49.4	7.8	6.2 ND
Silver	0.98 ND	0.93 ND	1.1 ND	1.1 ND	2.8 ND	2.7 ND	1.1 ND	1.6 ND	2.8 ND	1 ND	1.5 ND	0.73 ND	0.8 ND
Vanadium					66	71.3			66.9		291		
Zinc	11.1	18.6	64.4	18.7	69.3	70.1	46.8	67.6	67.3	173	282	209	27.1
<b>PESTICIDES/PCBs (ug/kg)</b>													
Dieldrin					6.9 ND	6.8 ND			6.2 ND		4.4 ND		
4,4'-DDE					0.76 JP	6.8 ND			6.2 ND		4.4 ND		
4,4'-DDT					6.9 ND	6.8 ND			6.2 ND		3.9 JP		
Aroclor-1254	26 ND	24 ND	29 ND	29 ND	69 ND	68 ND	28 ND	8300 ND	62 ND	28 ND	44 ND	26 ND	20 ND
Aroclor-1260	26 ND	24 ND	29 ND	29 ND	69 ND	68 ND	28 ND	8300 ND	62 ND	36 P	150	92	20 ND
TOTAL PCBs (ug/kg)	0	0	0	0	0	0	0	0	0	36	160	92	0

\* Pre-selected sample

South Carolina Aquarium Site  
Charleston, South Carolina  
UPLAND SOILS - HORIZON C SOIL SAMPLING RESULTS  
TABLE 3-4 (Continued)

SAMPLE NO.	B48-04 *	B48-10	B48-70 *	B60-42	B60-47	B61-27	B61-67	B62-06	B62-40	B63-14	B64-12	B64-32 *
<b>SEMI-VOLATILES (ug/kg)</b>												
<b>Polynuclear Aromatic Hydrocarbons</b>												
Naphthalene	1100 ND	7.5	410	7.7 B	11 B	1200000	84 B	18 JB	360 B	3300 B	570 B	1.5 JB
Acenaphthylene	1100 ND	2.9 J	88	11	12	85000 J	7.6	1.3 JB	46 B	820 ND	180 JB	0.088 JB
Acenaphthene	1100 ND	0.89 J	26	2.4 JB	3.6 B	38000 J	3.9 B	110	110	10000	5800 B	3.5 B
Fluorene	1100 ND	49	130	38	38	140000 J	31	68 JB	180 B	12000 B	2800 B	18 B
Phenanthrene	220 J	28	430	110	130	530000	150	36	1000	14000	28000	31
Anthracene	1100 ND	160	400	280	300	160000	130	83	820	58000	33000	39
Fluoranthene	190 J	88	340	31	39	280000	48	87	820	37000	25000 B	21 B
Pyrene	1100 ND	240	240	36	44	280000	68	67	400	27000 B	18000 B	12 B
Benzo(a)anthracene	1100 ND	18	83	18	19	130000 J	27	20	140	9900	3900 B	4.1 B
Chrysene	1100 ND	11	69	14 B	17 B	98000 J	33 B	770	14	520	460	21
Benzo(b)fluoranthene	97 JX	14	83	11	14	110000 JX	19	88	89	7100	4200 B	6.1 B
Benzo(k)fluoranthene	120 JX	9.9	41	8.4 B	9.8 B	110000 JX	14	27 B	79 B	4800 B	540	0.74 JB
Benzo(a)pyrene	1 ND	17	72	18	20	78000 J	27	31 B	130 B	9000 B	3400 B	4.2 B
Dibenz(a,h)anthracene	1100 ND	1.8	8.1	1.5	2	160000 ND	3.2	3 J	3.5 J	380	48 ND	0.14 J
Indeno(1,2,3-cd)pyrene	1100 ND	12	48	8.6	9.9	32000 J	14	22	74	4900	3400 B	3 B
Benzo(g,h,i)perylene	1100 ND	7.8	27	7.8	8.4	31000 J	9.6	22	43	1000	2000 B	0.34 JB
TOTAL PAHs (ug/kg)	827	838.79	2442.1	578.1	877.7	3273000	868.3	1413.3	3887.5	189010	130250	184.718
TOTAL C <sub>15</sub> PAHs (ug/kg)	217	84.7	372.1	76.4	81.7	560000	137.2	801	600.5	30710	15800	38.28
<b>Acid Extractables/Base Neutrals</b>												
2-Methylnaphthalene	1100 ND					210000						
Carbazole	1100 ND					60000 J						
<b>METALS (mg/kg)</b>												
Antimony	67.8	4.2 ND	6.8 ND	6.7 ND	8.1 ND	12.2 ND	6.9 ND	26.8	8.3 ND	9.3 ND	6.8 ND	7 ND
Arsenic	27.6	2.7	8.3	2.9	8.5	6.9	6.2	50.9	4.8	21.4	13.6	13
Beryllium	0.34 B	0.34 B	1.4	0.49 ND	0.52 ND	1 ND	0.51 ND	1.9	0.78	1.4	0.6 ND	0.6 ND
Cadmium	8.3	0.6 ND	0.82 ND	0.59 ND	0.82 ND	1.2 ND	0.81 ND	2.8	0.85 ND	0.98 ND	0.68 ND	0.72 ND
Chromium	187	8.1	38	9.8	14	18.3	10.1	282	11.8	48.2	17.2	21.7
Copper	1420	1.4 ND	8.8	1.7 ND	1.8 ND	3.7 ND	1.8 ND	333	5.2	18.8	206	9.7
Lead	1870	3.9	12.2	3.2	4.8	6.6	6.4	347	4.4	44	37.2	8.9
Manganese	884					108						
Mercury	0.98	0.13 ND	0.17 ND	0.14 ND	0.16 ND	0.16 ND	0.14 ND	0.68	0.16 ND	0.22 ND	0.14 ND	0.17 ND
Nickel	330	4.8 ND	12.3	4.7 ND	6 ND	10.7 B	4.9 ND	130	6.2 ND	17.9	7.1	6.8 ND
Silver	11.2	0.75 ND	1 ND	1 ND	1.1 ND	2.2 ND	1.1 ND	0.89 ND	1.2 ND	1.7 ND	1.1 ND	1.3 ND
Vanadium	366					20.9						
Zinc	6410	9.3	66	10.8	18.7	24	13.7	1800	18.7	67.8	80.8	28.4
<b>PESTICIDES/PCBs (ug/kg)</b>												
Dieldrin	4.8 JP					480 ND						
4,4'-DDE	2.6 JP					210 JP						
4,4'-DDT	5.3 ND					480 ND						
Aroclor-1254	63 ND	130 ND	34 ND	27 ND	28 ND	4800 ND	28 ND	2800 ND	30 ND	440 ND	27 ND	33 ND
Aroclor-1260	700 YP	130 ND	34 ND	27 ND	28 ND	4800 ND	28 ND	210000 P	33	440 ND	27 ND	33 ND
TOTAL PCBs (ug/kg)	700	0	0	0	0	0	0	210000	33	0	0	0

\* Pre-selected sample

South Carolina Aquarium Site  
Charleston, South Carolina  
UPLAND SOILS - HORIZON C SOIL SAMPLING RESULTS  
TABLE 3-4 (Continued)

SAMPLE NO.	B64-62 *	B64-82	B66-20 *	B66-26	B66-46	B66-60	B66-26	B67-26 *	B67-80 *	B67D80 *	B68-26	B68-30 *
<b>SEMI-VOLATILES (ug/kg)</b>												
<b>Polynuclear Aromatic Hydrocarbons</b>												
Naphthalene	13 B	430 ND	660	46000 B	91000 B	69000 B	130000 B	220 J	12 B	22 B	60000	12000 BD
Acenaphthylene	0.26 JB	430 ND	610 ND	38 J	400	370 J	1600 B	690 ND	1.2 JB	4.3 JB	9500 ND	290 D
Acenaphthene	3.8 JB	430 ND	280 J	6900 B	16000 B	6200 B	27000 B	180 J	1.8 J	3.7 JB	9300 J	4800 D
Fluorene	4.9 JB	430 ND	310 J	4600 B	12000 B	3000 B	33000 B	190 J	14 B	7.8 JB	7700 J	4100 D
Phenanthrene	30	430 ND	840	5600	21000	5600	20000	480 J	11	22	11000	5600 D
Anthracene	69	430 ND	330 J	1200	2300	320	98000	160 J	8.8	10 ND	9500 ND	780 D
Fluoranthene	8.7 B	430 ND	1300	460	3700	630	77000	370 J	8.3	18	1900 J	3600 BD
Pyrene	6 B	430 ND	1200	240	2300	400	64000	330 J	6.6	14	1300 J	2600 D
Benzo(a)anthracene	2.2 B	430 ND	800	12 J	220	89	12000 B	240 J	2.2	6.2	9500 ND	790 BD
Chrysene	1.6	430 ND	680 J	160 ND	110 ND	66 J	5400	140 J	6.6	6.1 ND	9500 ND	470 D
Benzo(b)fluoranthene	0.99 JB	69 JX	910 X	120 ND	110	41 J	10000	260 JX	1.2	3.3 J	9500 ND	300 BD
Benzo(k)fluoranthene	1.1 JB	69 JX	910 X	17 J	74 J	49 J	10000	260 JX	1.3 B	3.7 JB	9500 ND	360 BD
Benzo(a)pyrene	1.8 B	430 ND	410 J	12 JB	100 B	66 JB	11000	130 J	2 B	6.1 B	9500 ND	430 BD
Dibenz(a,h)anthracene	0.31 J	430 ND	120 J	120 ND	87 ND	11 J	860	690 ND	0.88 ND	0.86 J	9500 ND	36 D
Indeno(1,2,3-cd)pyrene	0.77 JB	430 ND	300 J	130 ND	33 J	110 ND	110000	690 ND	1.3	4.6 J	9500 ND	130 D
Benzo(g,h,i)perylene	0.7 JB	430 ND	290 J	130 ND	14 J	12 J	1800	690 ND	0.21 J	2.7 J	9500 ND	110 D
TOTAL PAHs (ug/kg)	134.02	118	9220	84969	148261	86664	601660	2910	78.31	117.16	81200	38186
TOTAL Cal*Ats (ug/kg)	8.07	118	4010	41	637	322	160260	1010	14.6	22.86	0	2606
<b>Acid Extractables/Base Neutrals</b>												
2-Methylnaphthalene		430 ND	180 J					88 J			6600 J	
Carbazole		430 ND	110 J					690 ND			11000	
<b>METALS (mg/kg)</b>												
Antimony	7.3 ND	11 ND	16.6 ND	7.1 ND	6.3 ND	6.8 ND	9.4 ND	17.6 ND	3	5.8 ND	12.7 ND	4.8 ND
Arsenic	7.3	3.8	10.6	8.8	6.1	6.3	21.6	17.6	2.3	4.6	10.8	4.9
Beryllium	0.82 B	1 B	1.3 ND	0.81 ND	0.46 ND	0.48 ND	1.3	1.6 ND	0.61 ND	0.6 ND	0.76 B	0.39
Cadmium	0.76 ND	1.1 ND	1.6 ND	0.73 ND	0.64 ND	0.68 ND	0.97 ND	1.8 ND	0.61 ND	0.6 ND	1.8 ND	0.66 ND
Chromium	39.8	21.6	22.4	28.4	16.8	16.6	32.4	28.4	47.3	44.6	28.6	10.3
Copper	6.9	3.3 ND	12.6	7.8	3.3	4	11.1	12.6	10.1	9.4	14.6	3.2 B
Lead	12.9	4.8	9.2	6.8	4.6	6.2	16.4	10.6	2.6	1.7	29.6	6.2
Manganese		97.4	174					241			243	
Mercury	0.17 ND	0.13 ND	0.19 ND	0.17 ND	0.13 ND	0.13 ND	0.23 ND	0.21 ND	0.14 ND	0.14 ND	0.19 ND	0.14 ND
Nickel	6 ND	9.1 ND	12.9 ND	9	4.4 ND	4.7 ND	12.1	14.6 ND	21.2	18.8	14.8 ND	6.4 ND
Silver	1.3 ND	2 ND	2.9 ND	1.3 ND	0.97 ND	1 ND	1.7 ND	3.2 ND	1.1 ND	1.1 ND	2.3 ND	0.82 ND
Vanadium		19.2	39.7					48.8			62.4	
Zinc	38	26.8	32.6	28	17.8	20.3	37.1	62.1	37.6	38	44.6	16.3
<b>PESTICIDES/PCBs (ug/kg)</b>												
Dieldrin		4.3 ND	6 ND					6.9 ND			6.3 ND	
4,4'-DDE		4.3 ND	6 ND					0.88 JP			6.3 ND	
4,4'-DDT		4.3 ND	6 ND					6.9 ND			6.3 ND	
Arochlor-1254	34 ND	43 ND	60 ND	170 ND	120 ND	130 ND	46 ND	69 ND	28 ND	28 ND	63 ND	27 ND
Arochlor-1280	34 ND	43 ND	60 ND	170 ND	120 ND	130 ND	46 ND	69 ND	16 JP	28 ND	63 ND	27 ND
TOTAL PCBs (ug/kg)	0	0	0	0	0	0	0	0	16	0	0	0

\* Pre-selected sample

South Carolina Aquarium Site  
Charleston, South Carolina  
UPLAND SOILS - HORIZON C SOIL SAMPLING RESULTS  
TABLE 3-4 (Continued)

SAMPLE NO.	B68-01 *	B68-12	B68-27	B68-65 *	B68-65 *	B68-78 *	B68-22 *	B68-42	B68-57	B68-12	B68-22	B68-57*
<b>SEMI-VOLATILES (ug/kg)</b>												
<b>Polynuclear Aromatic</b>												
<b>Hydrocarbons</b>												
Naphthalene	8.5 JB	58000 B	5700 D	710	15	2.5 J	60000 D	39 ND	39 ND	1100000 BD	30000 BD	3700
Acenaphthylene	5 JB	1700 B	940 DJ	590 ND	4.3 J	3.8 ND	8400 ND	37 ND	38 ND	24000 JD	8200 D	2500 ND
Acenaphthene	1.4 J	9500	3800 D	590 ND	21	4	27000 D	33 ND	34 ND	280000 B	11000 D	2500 ND
Fluorene	7.2 JB	8400 B	3300 D	590 ND	34	13	21000 D	20000 B	12000 B	450000 D	28000 D	2500 ND
Phenanthrene	110	44000	7700 D	590 ND	120	21	47000 D	5800	5900	1100000 D	87000 BD	480 J
Anthracene	730	46000	1800 D	590 ND	18	2 ND	10000 D	4400	2000	520000 D	13000 D	2500 ND
Fluoranthene	420	31000	2400 D	590 ND	95 B	13 B	34000 D	3000	200	700000 BD	42000 BD	280 J
Pyrene	300	17000	2000 D	590 ND	77 B	8.8 B	22000 D	2300	2200	440000 D	27000 BD	280 J
Benzo(a)anthracene	120 B	8700 B	1000 DJ	590 ND	34 B	3.3 B	11000 D	880 B	620 B	200000 BD	15000 BD	2500 ND
Chrysene	12	1100	780 DJ	590 ND	27 B	3.3 B	9900 D	550	420	240000 D	10000 D	2500 ND
Benzo(b)fluoranthene	38	4100	1000 DJX	590 ND	29	2.8	8700 DX	410	370	150000 BD	12000 D	2500 ND
Benzo(k)fluoranthene	120 B	4000 B	1000 DJX	590 ND	20 B	2.1 B	8700 DX	300	230	100000 BD	9300 BD	2500 ND
Benzo(a)pyrene	180 B	7100 B	700 DJ	590 ND	36 B	3.2 B	4500 DJ	330 B	280 B	170000 BD	14000 BD	2500 ND
Dibenz(e,h)anthracene	17	1100	140 DJ	590 ND	5.2	0.25 J	8400 ND	19	8.4 ND	22000 D	2200 D	2500 ND
Indeno(1,2,3-cd)pyrene	180	4200	350 DJ	590 ND	18	1.4	1100 DJ	120	85	8200 ND	830 ND	2500 ND
Benzo(g,h,i)perylene	180	1400	230 DJ	590 ND	19	2.8	8400 ND	87	79	74000 D	8100 D	2500 ND
TOTAL PAHs (ug/kg)	2416.1	243300	32850	710	589.5	81.05	264900	37970	24384	5550000	282800	4740
TOTAL C <sub>6</sub> PAHs (ug/kg)	645	30300	4990	0	168.2	16.45	43900	2399	2015	882000	82500	0
<b>Acid Extractables/Base Neutrals</b>												
2-Methylnaphthalene			5000 D	590 ND			15000 D					280 J
Carbazole			2600 D	590 ND			13000 D					2500 ND
<b>METALS (mg/kg)</b>												
Antimony	8	8.5 ND	18.9 ND	15.1 ND	7.7 ND	5.7 ND	14.1 ND	5.6 ND	5.6 ND	8.9 ND	7.1 ND	10.1 ND
Arsenic	9.2	18.1	11.3	8.2	8.6	8.7	13.2	5.4	5.9	21.7	18.5	5.2
Beryllium	0.43 ND	1.1	1.5 ND	1.8 B	1.5	0.49 ND	1.2 ND	0.48 ND	0.49 ND	1.3	1.2	0.88 B
Cadmium	0.51 ND	0.87 ND	1.7 ND	1.5 ND	0.79 ND	0.59 ND	1.4 ND	0.57 ND	0.58 ND	0.97 ND	1 ND	1.4 ND
Chromium	129	39	21.8	79.9	42.1	45.8	25.9	17.8	19	40.4	36.1	15.8
Copper	516	15.7	9.7 B	11.8	8.1	10.9	11.4	3.1 B	4	19.4	18	6.3 B
Lead	600	24.8	41.1	20.7	11	1.7	15.3	3.6	6.2	30.2	23.2	8.7
Manganese			148	292			417					104
Mercury	2.4	0.2 ND	0.2 ND	0.18 ND	0.18 ND	0.14 ND	0.17 ND	0.13 ND	0.13 ND	0.21 ND	0.21 ND	0.15 ND
Nickel	35.3	15.2	14 ND	20.4	10.7	21.5	11.7 ND	4.8 ND	4.7 ND	13.3	11.7	11.8 ND
Silver	0.92 ND	1.8 ND	3.1 ND	2.8 ND	1.4 ND	1.1 ND	2.6 ND	1 ND	1 ND	1.2 ND	1.3 ND	1.8 ND
Vanadium			25.8	70.1			51.2					15.2
Zinc	887	58.5	31.1	87.7	51.8	45.9	38.4	15.2	26.2	85.8	56.2	24.4
<b>PESTICIDES/PCBs (ug/kg)</b>												
Dieldrin			0.8 JP	5.9 ND			5.8 ND					5 ND
4,4'-DDE			2.8 JP	5.9 ND			2.3 JP					5 ND
4,4'-DDT			1.1 JP	5.9 ND			5.7					5 ND
Arochlor-1254	24 ND	41 ND	68 ND	59 ND	37 ND	27 ND	58 ND	28 ND	27 ND	210 ND	2100 ND	50 ND
Arochlor-1260	900	41 ND	68 ND	59 ND	37 ND	27 ND	58 ND	28 ND	27 ND	210 ND	2100 ND	50 ND
TOTAL PCBs (ug/kg)	900	0	0	0	0	0	0	0	0	0	0	0

South Carolina Aquarium Site  
Charleston, South Carolina  
UPLAND SOILS - HORIZON C SOIL SAMPLING RESULTS  
TABLE 3-4 (Continued)

SAMPLE NO.	870-37 *	870D37 *	870-57 *	888-22 *	888-52 *	888-22	888-37	888-57	890-07 *	890-32 *	891-12	891-32 *	891-52 *
<b>SEMI-VOLATILES (ug/kg)</b>													
<b>Polynuclear Aromatic</b>													
<b>Hydrocarbons</b>													
Naphthalene	18 B	32 B	9200 B	11	580 ND	950	10000	170	480	4700	1500000	5900	1000
Acenaphthylene	3.7 ND	7.7 ND	2 J	4.2 ND	580 ND	200 ND	780	9.1	17 ND	730 J	230000	410	58 J
Acenaphthene	16 B	28 B	18 B	6.3	580 ND	64 J	2000	25	320	580 J	220000	440	230 J
Fluorene	6.3 ND	31	6.4 ND	52	580 ND	620	5400	120	130	1400	470000	1500	350 J
Phenanthrene	23	61	22	2.4 ND	580 ND	1200	4400	93	1400	5400	1200000	7400	1100
Anthracene	31	74	12	99	580 ND	580	15000	220	1600	1300	380000	1400	310 J
Fluoranthene	5.5 B	18 B	11 B	57	580 ND	680	13000	280	82	3800	830000	4000	890
Pyrene	3.8 B	11 B	7.8 B	34	580 ND	530	10000	210	40	3000	890000	200	840
Benzo(a)anthracene	1.8	0.087 J	2.6	15 B	580 ND	210	4100	78	13 B	1500	440000	4.5 JB	320 J
Chrysene	13	37	12	8.7	580 ND	130	2300	60	250	1000	300000	410	210 J
Benzo(b)fluoranthene	4.6	15	1.5	12	580 ND	180	3300	58	28	1300	360000 X	1400	300 JX
Benzo(k)fluoranthene	2 B	7.3 B	1.3 B	7.4 B	580 ND	120	2300	43	6.8	1800	360000 X	110	300 JX
Benzo(a)pyrene	2.2	7	1.8	13 B	580 ND	200 B	4000 B	73 B	51 B	920 J	250000	33 J	180 J
Dibenz(a,h)anthracene	0.75 J	1.1 J	0.85 ND	2.1	580 ND	6.5 J	430	7.7	4.2 ND	110 J	50000 J	60	550 ND
Indeno(1,2,3-cd)pyrene	1 J	4.7	1.3	7	580 ND	120	2000	39	4.8 ND	570 J	180000 J	530	78 J
Benzo(g,h,i)perylene	2.9	11	2.1	5.6	580 ND	140	1800	32	18	430 J	140000 J	18 J	550 ND
TOTAL PAHs (ug/kg)	125.55	338.187	9295.5	329.1	0	5730.5	80810	1497.8	4388.8	28120	7580000	23813.5	5772
TOTAL CoPAHs (ug/kg)	25.35	72.187	20.0	85.2	0	800.5	18430	358.7	348.8	7000	1820000	2547.5	1388
<b>Acid Extractables/Base Neutrals</b>													
<b>2-Methylnaphthalene</b>													
Carbazole					580 ND					1500	480000		280 J
					580 ND					520 J	150000 J		95 J
<b>METALS (mg/kg)</b>													
Antimony	5.7 ND	5.8 ND	5.7 ND	6.4 ND	14.6 ND	8 ND	5.5 ND	5.3	5.1 ND	12 ND	18.4 ND	8.1 ND	14.1 ND
Arsenic	3.5	4.1	3.1	10.3	8.4	10.8	1.8	1 B	21.9	4.8	17	4.8	9
Beryllium	0.48 ND	0.5 ND	0.49 ND	0.58 B	1.3 ND	0.58 B	0.47 ND	0.82	0.44 ND	1 ND	1.6 ND	0.52 ND	1.2 ND
Cadmium	0.58 ND	0.59 ND	0.59 ND	0.65 ND	1.5 ND	0.81 ND	0.58 ND	0.53 ND	0.53 ND	1.2 ND	1.9 ND	0.62 ND	1.4 ND
Chromium	8	10.5	14.6	19.9	31.7	15.8	8.4	14.9	10.2	18.2	51.7	11.3	36.8
Copper	1.7 ND	1.8 ND	3.6	2.8 B	6 B	3.5 B	2 B	3.8	18.4	3.6 ND	27.1	3.9	8.5
Lead	4.1	4.1	7.8	6.7	9.7	4.9	22.7	5.5	19.6	3.5	31.8	13.8	12.3
Manganese					180					48.5	317		185
Mercury	0.14 ND	0.14 ND	0.14 ND	0.15 ND	0.17 ND	0.14 ND	0.13 ND	0.12 ND	0.12 ND	0.14 ND	0.22 ND	0.15 ND	0.17 ND
Nickel	4.7 ND	4.8 ND	4.7 ND	5.5 B	12.1 ND	4.9 ND	4.5 ND	4.9	18.7	9.8 ND	20.9	5 ND	15
Silver	1 ND	1.1 ND	1 ND	1.2 ND	2.7 ND	1.1 ND	1 ND	0.94 ND	0.94 ND	2.2 ND	3.4 ND	1.1 ND	2.8 ND
Vanadium					34					14.5	80.6		39
Zinc	11.1	14.9	24.8	24.9	27.8	18.3	11.7	12.8	24.2	15.2	77.7	14.1	34.4
<b>PESTICIDES/PCBs (ug/kg)</b>													
<b>Dieldrin</b>													
4,4'-DDE					5.8 ND					4.7 ND	28 JP		1.1 JP
4,4'-DDT					5.8 ND					0.37 JP	38 ND		0.33 JP
Arochlor-1254	27 ND	27 ND	27 ND	30 ND	58 ND	28 ND	28 ND	24 ND	24 ND	47 ND	380 ND	28 ND	55 ND
Arochlor-1280	27 ND	27 ND	27 ND	30 ND	58 ND	28 ND	28 ND	24 ND	24 ND	47 ND	380 ND	28 ND	55 ND
TOTAL PCBs (ug/kg)	0	0	0	0	0	0	0	0	0	0	0	0	0

## DATA REPORTING QUALIFIERS FOR ORGANICS

- VALUE - If the result is a value greater than or equal to the Contract Required Quantitation Limit (CRQL), report the value.
- ND or U - Indicates analyte was analyzed for but not detected.
- J - Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the sample quantitation limit but greater than zero.
- N - Indicates presumptive evidence of a compound. This flag is only used for tentatively identified compounds.
- P - This flag is used for a pesticide/Aroclor target analyte when there is greater than 25% difference for detected concentrations between the two GC columns. The lower of the two values is reported on Form I and flagged with a "P".
- C - This flag applies to pesticide results where the identification has been confirmed by GC/MS.
- B - This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action. The results have been flagged with this qualifier even if the analyte was found in the associated blank at acceptable levels (i.e. less than the CRQL).
- E - This flag identifies compounds whose concentrations exceed the calibration range of the GC/MS instrument for the specific analysis.
- D - This flag identifies all compounds identified in an analysis at a secondary dilution factor.
- X - Other specific flags and footnotes required to properly define the results.
- Y - The "Y" flag is used to denote pesticide/PCB compounds that could not be confirmed by GC/MS. The results from the GC/MS confirmation are included in the sample data package.

## DATA REPORTING QUALIFIERS FOR INORGANICS

### C (Concentration) Qualifiers:

- B - The reported value was obtained from a reading that was less than the Contract Required Detection Limit (CRDL) but greater than or equal to the Instrument Detection Limit (IDL).
- ND or U - Indicates analyte was analyzed for but not detected.

### O Qualifier:

- E - The reported value is estimated because of the presence of interference.
- M - Duplicate injection precision not met.
- N - Spiked sample recovery not within control limits.
- A or S - The reported value was determined by the Method of Standard Additions (MSA).
- W - Post-digestion spike for Furnace AA analysis is out of control limits (85-115%), while sample absorbance is less than 50% of spike absorbance.
- \* - Duplicate analysis not within control limits.
- + - Correlation coefficient for the MSA is less than 0.995.

### M (Method) Qualifier:

- "P" - for ICP
- "A" - for Flame AA
- "F" - for Furnace AA
- "PM" - for ICP when Microwave Digestion is used
- "AM" - for Flame AA when Microwave Digestion is used
- "FM" - for Furnace AA when Microwave Digestion is used
- "CV" - for Manual Cold Vapor AA
- "AV" - for Automated Cold Vapor AA
- "CA" - for Midi-Distillation Spectrophotometric
- "AS" - for Semi-Automated Spectrophotometric
- "C" - for Manual Spectrophotometric
- "T" - for Titrimetric
- " " - where no data has been entered
- "NR" - if the analyte is not required to be analyzed.

South Carolina Aquarium Site  
Charleston, South Carolina  
INTERTIDAL SOILS - SHALLOW SAMPLING RESULTS  
TABLE 3-6

SAMPLE NO.	B37-04 *	B37-08	B48-02 *	B48-04 *	B82-04	B83-02 *	B83-04	B83-10	B84-04	B84-08	B85-02 *	B85-04 *
<b>SEMI-VOLATILES (ug/kg)</b>												
<b>Polynuclear Aromatic Hydrocarbons</b>												
Naphthalene	620 JB	76 J	88 JB	1300 J	27000 ND	7400 B	1300 B	44000	970 ND	300 J	1400 JB	280 ND
Acenaphthylene	900 ND	400 ND	80 JB	1400 J	16000 DJ	2100 ND	760 ND	24000 ND	930 ND	170 J	3000 ND	270 ND
Acenaphthene	810 ND	400 ND	110 J	1700 J	21000 DJ	11000	1800	24000 ND	9100 BD	3600	4000	240 ND
Fluorene	1500 ND	400 ND	340 J	1700 J	8800 DJ	8400 B	2600 B	24000 ND	1800 ND	2000	3800 J	450 ND
Phenanthrene	3800 B	160 J	2800	13000	32000 D	44000 B	8600 B	8400 J	2200 D	2000	14000	2000
Anthracene	950	62 J	270 ND	5800 J	11000 DJ	12000	410 ND	3000 J	22000 D	17000	4800	140 ND
Fluoranthene	5500 B	610	1600	21000	160000 D	38000 B	9000 B	5800 J	14000 BD	9800	18000 B	4200 B
Pyrene	6400 B	400	4800	20000	180000 D	30000 B	8100 B	3800 J	12000 BD	7100	15000	2800
Benzo(a)anthracene	2800 B	300 J	2800 B	13000	110000 D	28000 B	3600 B	2600 J	3200 BD	2600	7800 B	1300 B
Chrysene	2800	230 J	1900	8400	84000 D	7800	3400	24000 ND	2600 D	1800	16000	2200
Benzo(b)fluoranthene	3000	270 JX	3100 B	12000 X	80000 DX	11000	3600	24000 ND	3300 D	2200	8400 B	2000 B
Benzo(k)fluoranthene	1600 B	280 JX	2000 B	17000 X	72000 DX	7800 B	2000 B	2400 J	2300 D	1700	4700 B	1200 B
Benzo(a)pyrene	2600 B	160 J	3200 B	8600	47000 D	22000 B	3100 B	24000 ND	3200 BD	2700	7300 B	1000 B
Dibenz(a,h)anthracene	430 B	400 ND	390 B	8100 ND	8300 DJ	1300 B	14 JB	24000 ND	320 D	320	1300	290
Indeno(1,2,3-cd)pyrene	700	87 J	1400	2800 J	23000 DJ	4400	210 ND	24000 ND	1800 D	1400	3400	76 ND
Benzo(g,h,i)perylene	1200 B	400 ND	1900	2300 J	4400 DJ	4400 B	1600 B	24000 ND	940 D	1200	3400	840
TOTAL PAHs (ug/kg)	32100	2624	28288	130600	802600	238300	48314	87900	77080	66390	110800	17930
TOTAL CaPAHs (ug/kg)	13730	1327	14690	82600	402300	80100	16614	4800	10820	12420	46700	7880
<b>Acid Extractables/Base Neutrals</b>												
2-Methylnaphthalene		400 ND		8100 ND	27000 ND			6700 J				
Carbazole		400 ND		8100 ND	27000 ND			24000 ND				
<b>METALS (mg/kg)</b>												
Antimony	18.3	8.1 ND	17.6	38.7	22.8 ND	61.2	94.6	108	11.1 ND	9.7 ND	11.7	89
Arsenic	9.9	1.7 B	3.8	126	66.6	31.6	67.2	28.2	18.2	27.6	28.7	60.2
Beryllium	1.6	0.17 ND	1.3	2 B	1.4 B	1.6	1.7	0.34 ND	0.96 B	1.6	10.9	4.1
Cadmium	0.76 ND	1.1 ND	1.1	3.1	1.8 ND	2.6	6.1	13.9	1.8 ND	1.4 ND	1 ND	6.8
Chromium	31	10.9	71.8	8020	36.9	109	187	164	63.8	38.2	101	121
Copper	68.8	2.6 ND	1170	602	31.7	838	1200	980	75.6	60.6	1410	75100
Lead	86.2	8.4	1470	680	61.2	1290	1980	10600	102	41.7	1720	1140
Manganese		9.8		497	387			2060				
Mercury	3.2	0.12 ND	1.2	9.7	0.38	1.8	3	0.86	0.63	0.3	6.3	13.3
Nickel	48.4	8.4 ND	67.7	120	10.6 B	123	141	110	15.8	11.2 ND	119	180
Silver	0.88 ND	1.4 ND	1.1 ND	3 ND	1.4 ND	1.3 B	4.4	6.8	2 ND	1.7 ND	1.8 B	4.3
Vanadium		16.8		701	68.7			163				
Zinc	371	9	1070	11800	104	2300	3690	3300	176	198	1320	1940
<b>PESTICIDES/PCBs (ug/kg)</b>												
Dieldrin		4 ND		8.2 ND	6.8 ND			17 JP				
4,4'-DDE		4 ND		19	6.8 ND			20 JP				
4,4'-DDT		1.3 J		2.7 JP	6.8 ND			40 ND				
Arochlor-1254	4400 P	40 ND	380 ND	82 ND	260 P	2800	3700	400 ND	880 ND	2800 ND	43 ND	38 ND
Arochlor-1260	8200	40 ND	600	380 PY	68 ND	420 JP	8600	8400 PC	860 ND	2800 ND	400	120 P
TOTAL PCBs (ug/kg)	10800	0	600	380	260	3220	10200	8400	0	0	400	120

\* Pre-selected sample

South Carolina Aquarium Site  
Charleston, South Carolina  
INTERTIDAL SOILS - SHALLOW SAMPLING RESULTS  
TABLE 3-6 (Continued)

SAMPLE NO.	B71-04 *	B72-04	B73-02	B74-04	B76-02 *	B76-06	B78-02 *	B78-04 *	B77-02 *	B77-04 *	B78-02 *	B78-06
<b>SEMI-VOLATILES (ug/kg)</b>												
<b>Polynuclear Aromatic Hydrocarbons</b>												
Naphthalene	870 J	2400 ND	84 J	480 J	63 J	3600	9300	150 B	3400 B	2700 J	180 B	30000 B
Acenaphthylene	4100 ND	480 J	280 ND	680 J	78 ND	3100 ND	1400 J	68 JB	780 ND	3000 ND	71 ND	820 J
Acenaphthene	4100 ND	670 J	280	810 J	41 J	3300	1100 J	210	3100	14000	270	46000
Fluorene	4100 ND	340 J	310 J	480 J	110 J	1800 J	2300 J	140 J	1400 JB	8800	300 B	41000 B
Phenanthrene	1200 J	3000	3800 B	2800 J	3200	7000	12000	1400	6400 B	21000	2100 B	88000 B
Anthracene	4100 ND	800 J	890	1100 J	4100	2700 J	3800	77 ND	1000	2800 J	240	13000
Fluoranthene	3800 J	6200	8200	7800	8500	13000	13000	2100 B	6700 B	11000	3000 B	49000 B
Pyrene	7000	6800	3300	3800 J	8800	11000	11000	3800 B	8800 B	8800	2800 B	39000 B
Benzo(a)anthracene	3400 J	3500	1300 B	3800 J	1000	4800	7700	940 B	2100 B	3200	880 B	10000 B
Chrysene	2100 J	3000	2600	2500 J	330	4400	6400	2000	2100	2100 J	1200	7400
Benzo(b)fluoranthene	4800 X	3300	1700	3800 XJ	1100	6700 X	7300 X	700 B	2800	2600 JX	1300	7000
Benzo(k)fluoranthene	6300 X	1700 J	900	4000 XJ	180	7400 X	7800 X	770 B	1800 B	2800 JX	790 B	4700 B
Benzo(a)pyrene	2700 J	2600	1700 B	1800 J	73	3100 ND	4400	1200 B	1800 B	1600 J	1100 B	6000 B
Dibenz(a,h)anthracene	4100 ND	2400 ND	410	700 J	37	3100 ND	840 J	130	230 B	3000 ND	180 B	880 B
Indeno(1,2,3-cd)pyrene	880 J	680 J	470	1600 J	400	760 J	3000	700	340	700 J	280	2100
Benzo(g,h,i)perylene	1400 J	640 J	700	4800 ND	38	3100 ND	1800 J	1000 B	870 B	3000 ND	480 B	1800 B
TOTAL PAHs (ug/kg)	33130	32810	28824	36850	28060	65560	92740	16108	41640	82700	16200	346810
TOTAL CaPAHs (ug/kg)	18980	14780	8080	18100	3120	23160	37440	8440	10870	12800	6740	37890
<b>Acid Extractables/Base Neutrals</b>												
2-Methylnaphthalene	4100 ND	2400 ND		4800 ND		1600 J	2600 J			4600		
Carbazole	4100 ND	2400 ND		4800 ND		600 J	1800 J			2000 J		
<b>METALS (mg/kg)</b>												
Antimony	38.8	16	28.8	24.8	10	11.3	18.8	48.8	10.7	15.8	74	46.8
Arsenic	26.3	11.2	40.1	41.8	22.6	63.7	36.8	60.5	11	21.8	29.7	38.2
Beryllium	0.38 B	0.87 B	1.3	0.4	0.67	1.7 B	1.5 B	1.7	0.76	0.69 B	0.99	1.4
Cadmium	2.8	2.3	2	4.4	0.88	2.9	16	1.8	0.85 ND	1.7 ND	1.3	1.1 ND
Chromium	220	226	106	208	177	136	171	314	86.7	80.3	130	76.4
Copper	4730	1080	3370	448	178	888	4280	802	480	373	8800	137
Lead	722	776	1420	3330	766	868	3460	1040	201	374	1860	336
Manganese	148	210		1180		364	2660			288		
Mercury	12.1	1.3	0.97	6.7	4.1	7.8	29.1	28.4	4.6	3.1	3	0.67
Nickel	27.6	68.1	61.6	668	22.1	61.8	77.2	74.9	12.2	21.3	160	24.8
Silver	1.6 ND	1.8 ND	1.2 ND	1.7 ND	0.79 ND	2 ND	2 ND	1.6 ND	0.82 ND	2.2 ND	1.6	1.4 ND
Vanadium	80.7	128		6380		648	648			66.7		
Zinc	3180	2830	1680	2380	898	2740	6740	2760	600	1470	1870	1020
<b>PESTICIDES/PCBs (ug/kg)</b>												
Dieldrin	0.23 JP	17 P		16 P		4.8 JP	6.6 JP			6.1 P		
4,4'-DDE	6.4 P	4.8 ND		4.7 ND		32 P	37 P			4.2 JP		
4,4'-DDT	4.2 ND	9.1 P		4.7 ND		8.2 ND	28 ND			6.1 ND		
Arochlor-1254	320	48 ND	21000 ND	47 ND	130 ND	82 ND	280 ND	280 ND	6000	81 ND	23000	980 ND
Arochlor-1260	42 ND	680 PY	21000 ND	47 ND	48 JP	82 ND	280 ND	170 J	2800 ND	61 ND	2600 ND	980 ND
TOTAL PCBs (ug/kg)	320	680	0	0	48	0	0	170	6000	0	23000	0

\* Pre-selected sample

South Carolina Aquarium Site  
Charleston, South Carolina  
INTERTIDAL SOILS - SHALLOW SAMPLING RESULTS  
TABLE 3-5 (Continued)

SAMPLE NO.	B79-04	B80-02 *	B80-04	B81-04	B82-02	B83-04	B84-08	B86-02 *	B86-08	B86-02	B87-04	B87-10
<b>SEMI-VOLATILES (ug/kg)</b>												
<b>Polynuclear Aromatic Hydrocarbons</b>												
Naphthalene	640 ND	240 ND	580 J	480 J	110 B	650 J	210000 D	2700 ND	470000	5700	87 JB	2600000 B
Acenaphthylene	820 ND	24 JB	180 J	480 ND	6.7 JB	2700 ND	11000 DJ	1800 J	23000 J	4900 ND	82 J	210000
Acenaphthene	680 ND	88 J	230 J	820	48	280 J	82000 D	2400 ND	150000	9100	580 J	280000
Fluorene	1000 ND	150 J	180 J	920	140	2700 ND	87000 D	4400 ND	170000	7700	820 J	700000
Phenanthrene	1800	2400	380 J	8700 B	800	380 J	180000 D	1500 ND	530000	33000	3700	1700000
Anthracene	330 ND	120 ND	150 J	710	1100	320 J	83000 D	1800	170000	10000	1500	450000
Fluoranthene	1800	2000	780 J	8300	480	3600	110000 D	1800	370000	32000	13000 B	1200000 B
Pyrene	3100 B	1500	1100	1700	450	2400 J	88000 D	2700	250000	30000	14000	800000
Benzo[a]anthracene	1200 B	870 B	520 J	2600 B	180 B	1700 J	80000 D	1100 B	120000 B	24000	3800 B	340000 B
Chrysene	3800	950	480 J	4400	220	2000 J	50000 D	1800	75000	24000	8300	250000
Benzo[b]fluoranthene	1300	170	800 X	2800	120	2700 X	83000 DX	1400 B	98000 B	26000 X	6600 B	260000 B
Benzo[k]fluoranthene	850 B	750 B	1100 X	1700	110 B	3300 X	81000 DX	800 B	88000	35000 X	4000 B	180000 B
Benzo[a]pyrene	1400 B	1000	800 ND	2700 B	180	820 J	45000 D	1000 B	100000 B	13000	4800 B	280000 B
Dibenz[a,h]anthracene	200	220	800 ND	330	40	380 J	27000 ND	170 J	16000	2700 J	830	38000
Indeno[1,2,3-cd]pyrene	410	810	180 J	880	14 ND	680 J	13000 DJ	480 J	44000	4700 J	2200	110000
Benzo[g,h,i]perylene	470	840	1700	890	170	2700 ND	7700 DJ	420 J	38000	3800 J	2200	120000
TOTAL PAHs (ug/kg)	16630	11550	8330	34110	4144.7	19200	1120700	15150	2880000	280800	64208	9518000
TOTAL Cal/AIIs (ug/kg)	9180	4770	3040	15410	880	11580	312000	6830	518000	128400	28430	1458000
<b>Acid Extractables/Base Neutrals</b>												
2-Methylnaphthalene			84 J			2700 ND	59000 D			1800 J		
Carbazole			800 ND			2700 ND	22000 DJ			8000		
<b>METALS (mg/kg)</b>												
Antimony	21.3	17.3	18.4 ND	48.8	45.4	21.5	13.5 ND	9.4	7 ND	43.4	15.1	7.5 ND
Arsenic	61	28.8	27.2	56.8	33.9	36.6	25	18	28.8	57.3	31.8	22.1
Beryllium	2.2	1.8	3.4	9.8	2.9	0.86 B	0.73 B	1.8	1.3	3.4	1.5	1.3
Cadmium	1.4	0.77 ND	2.9	4	2.8	3.7	1.8 ND	0.89 ND	0.88 ND	2.5	3.3	1.1 ND
Chromium	95.4	132	91.5	148	785	215	34.1	55.8	38.8	240	110	38.8
Copper	138	287	188	408	251	1380	58.8	154	21.8	533	242	18.4
Lead	1120	912	1150	3740	4380	622	233	274	52.2	1280	1750	41.1
Manganese			375			535	380			2650		
Mercury	0.65	2.5	1.3	2.8	0.75	8.2	0.46	3.1	0.21 ND	7.4	1.3	0.23 ND
Nickel	72.8	65.8	114	184	132	39.8	33.4	51.3	14.5	147	73.4	13
Silver	1.3 ND	0.88 ND	2.9 ND	1.5 B	1.1 ND	2 ND	2.4 ND	1.1 ND	1.2 ND	1.8 ND	1.5 ND	1.3 ND
Vanadium			1580			208	59.8			1600		
Zinc	484	1040	1250	3080	1350	2450	288	378	80	1740	1560	51.6
<b>PESTICIDES/PCBs (ug/kg)</b>												
Dieldrin			8 ND			3.3 JP	34 ND			4.9 ND		
4,4'-DDE			7.7 J			5.4 ND	34 ND			4.9 ND		
4,4'-DDT			0.88 JP			5.4 ND	34 ND			4.9 ND		
Arochlor-1254	220 ND	330 ND	80 ND	170 ND	3500 ND	54 ND	340 ND	18000 ND	2100 ND	48 ND	2500 ND	230 ND
Arochlor-1260	1100	180 J	80 ND	800	3500 ND	44 JP	340 ND	18000 ND	2100 ND	480 Y	2500 ND	230 ND
TOTAL PCBs (ug/kg)	1100	180	0	800	0	44	0	0	0	480	0	0

\* Pre-selected sample

## DATA REPORTING QUALIFIERS FOR ORGANICS

- VALUE - If the result is a value greater than or equal to the Contract Required Quantitation Limit (CRQL), report the value.
- ND or U - Indicates analyte was analyzed for but not detected.
- J - Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the sample quantitation limit but greater than zero.
- N - Indicates presumptive evidence of a compound. This flag is only used for tentatively identified compounds.
- P - This flag is used for a pesticide/Aroclor target analyte when there is greater than 25 % difference for detected concentrations between the two GC columns. The lower of the two values is reported on Form I and flagged with a "P".
- C - This flag applies to pesticide results where the identification has been confirmed by GC/MS.
- B - This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action. **The results have been flagged with this qualifier even if the analyte was found in the associated blank at acceptable levels (i.e. less than the CRQL).**
- E - This flag identifies compounds whose concentrations exceed the calibration range of the GC/MS instrument for the specific analysis.
- D - This flag identifies all compounds identified in an analysis at a secondary dilution factor.
- X - Other specific flags and footnotes required to properly define the results.
- Y - The "Y" flag is used to denote pesticide/PCB compounds that could not be confirmed by GC/MS. The results from the GC/MS confirmation are included in the sample data package.

## DATA REPORTING QUALIFIERS FOR INORGANICS

### C (Concentration) Qualifiers:

- B - The reported value was obtained from a reading that was less than the Contract Required Detection Limit (CRDL) but greater than or equal to the Instrument Detection Limit (IDL).
- ND or U - Indicates analyte was analyzed for but not detected.

### Q Qualifier:

- E - The reported value is estimated because of the presence of interference.
- M - Duplicate injection precision not met.
- N - Spiked sample recovery not within control limits.
- A or S - The reported value was determined by the Method of Standard Additions (MSA).
- W - Post-digestion spike for Furnace AA analysis is out of control limits (85-115%), while sample absorbance is less than 50% of spike absorbance.
- \* - Duplicate analysis not within control limits.
- + - Correlation coefficient for the MSA is less than 0.995.

### M (Method) Qualifier:

- "P" - for ICP
- "A" - for Flame AA
- "F" - for Furnace AA
- "PM" - for ICP when Microwave Digestion is used
- "AM" - for Flame AA when Microwave Digestion is used
- "FM" - for Furnace AA when Microwave Digestion is used
- "CV" - for Manual Cold Vapor AA
- "AV" - for Automated Cold Vapor AA
- "CA" - for Midi-Distillation Spectrophotometric
- "AS" - for Semi-Automated Spectrophotometric
- "C" - for Manual Spectrophotometric
- "T" - for Titrimetric
- " " - where no data has been entered
- "NR" - if the analyte is not required to be analyzed.

South Carolina Aquarium Site  
Charleston, South Carolina  
INTERTIDAL SOILS - DEEP SAMPLING RESULTS

TABLE 3-6

SAMPLE NO.	B37-40 *	B48-70 *	B48D70 *	B62-20	B62-60*	B62-65*	B64-20	B64-32	B66-12	B66-25	B66D25	B66-17
SEMI-VOLATILES (ug/kg)												
Polynuclear Aromatic												
Hydrocarbons												
Naphthalene	3.9 JB	6.2 ND	2.9 J	100000	1400	540	880000	1900000	9300 B	8300	2300	480000 B
Acenaphthylene	1.2 J	5 ND	5.1 ND	3800	180	24	91000 J	230000	3100	3400 ND	840 ND	21000
Acenaphthene	1.3 J	4.4 ND	4.4 J	4500	51	18 J	38000 J	51000	28000	3400 ND	220 J	130000
Fluorene	25 B	28	4.5 J	7300	410	130	140000	380000	44000	3400 ND	220 J	180000
Phenanthrene	75 B	18 B	25 B	8100	930	410	410000	110000	93000	640 J	700	71000
Anthracene	250	6.3	4.9	310 ND	130	53	130000	1100000	18000	3400 ND	250 J	270000
Fluoranthene	18 B	3.1	18	5000	140	250	270000	670000	67000 B	770 J	880	330000
Pyrene	18 B	9.7	10	3100 B	120 B	35 B	240000	580000	48000	720 J	530 J	280000
Benzo(a)anthracene	7.7 B	3.3 B	5.5 B	2100 B	240 B	87 B	130000	200000	22000 B	500 J	380 J	100000 B
Chrysene	6.2	3.5	5.3	1900 B	270	81	91000 J	110000	19000	430 J	260 J	98000
Benzo(b)fluoranthene	12	1.8	4.8	1800	220	80	100000 J	140000	17000 B	480 JX	400 JX	110000
Benzo(k)fluoranthene	6.1 B	0.26 J	3.3	1300 B	140 B	52 B	58000 J	110000	13000 B	550 JX	380 JX	82000 B
Benzo(a)pyrene	3.9 B	2.9 B	6.1 B	2400 B	240 B	80 B	93000 J	170000	19000 B	3400 ND	230 J	100000 B
Dibenz(a,h)anthracene	0.52 JB	0.48 J	1.4	550	38	14	110000 ND	16000	2800	3400 ND	640 ND	11000
Indeno(1,2,3-cd)pyrene	1.1 ND	1.1 J	3	800	100	32	25000 J	93000	8800	3400 ND	90 J	85000
Benzo(g,h,i)perylene	1.4 B	1.1 J	2.8	780	100	28	18000 J	58000	11000	3400 ND	640 ND	45000
TOTAL PAHs (ug/kg)	431.22	77.54	100	144630	4688	1814	2521000	5928000	424200	12370	6800	2381000
TOTAL CaPAHs (ug/kg)	35.42	13.34	28.5	10950	1248	428	485000	838000	101800	1940	1720	544000
Acid Extractables/Base Neutrals												
2-Methylnaphthalene												
Carbazole							180000			990 J	580 J	
							47000 J			3400 ND	81 J	
METALS (mg/kg)												
Antimony	4.8 ND	6 ND	6.1 ND	8.8 ND	4.8 ND	4.8 ND	14.9 ND	7.5 ND	9.8	13.8 ND	13.8 ND	8.2 ND
Arsenic	7.1	9.8	10.8	17.5	8.8	5.5	20.8	17.4	28.4	23.8	15.8	14.3
Beryllium	0.21 B	1.2	1.2	1.2	0.9	0.53 B	1.2 B	1.1 B	1.3	1.2 B	1.1 B	1.3
Cadmium	0.68 ND	0.84 ND	0.86 ND	0.95 ND	0.69 ND	0.68 ND	2.1 ND	1.1 ND	1 ND	1.9 ND	2 ND	1.2 ND
Chromium	9.8	36.8	31.4	36.4	33.7	17.9	34.8	28.5	63.2	39.7	38.3	42.5
Copper	1.5 ND	7.1	8.4	15	4.5	4.1	14	13.3	60.4	16.5	18.8	38.3
Lead	3.1	14.6	13.6	13.9	11.2	5.7	11.3	20.3	89.1	23.1	36.5	56.1
Manganese							474			357	327	
Mercury	0.14 ND	0.18 ND	0.18 ND	0.2 ND	0.15 ND	0.15 ND	0.22 ND	0.22 ND	0.37	0.21 ND	0.21 ND	0.46
Nickel	5.6 ND	7.9	11.5	14.5	10.1	5.7 ND	17.3 ND	8.7 ND	43.3	16.1 ND	16.3 B	13.5
Silver	0.88 ND	1.1 ND	1.1 ND	1.2 ND	0.87 ND	0.86 ND	2.6 ND	1.3 ND	1.3 ND	2.4 ND	2.4 ND	1.5 ND
Vanadium							61.8			71.3	68.1	
Zinc	15.5	47.4	45.2	45.9	33	22.8	43.4	40.5	339	48.2	51.1	89.4
PESTICIDES/PCBs (ug/kg)												
Dieldrin												
4,4'-DDE							38 ND			8.9 ND	8.4 ND	
4,4'-DDT							36 ND			6.9 ND	6.4 ND	
							4.8 JP			6.9 ND	6.4 ND	
Arochlor-1254	29 ND	35 ND	37 ND	820 ND	29 ND	29 ND	360 ND	880 ND	860 ND	69 ND	64 ND	5000 ND
Arochlor-1260	29 ND	35 ND	37 ND	820 ND	29 ND	29 ND	380 ND	880 ND	7500 P	69 ND	64 ND	5000 ND
TOTAL PCBs (ug/kg)	0	0	0	0	0	0	0	0	7500	0	0	0

\* Pre-selected sample

South Carolina Aquarium Site  
Charleston, South Carolina  
INTERTIDAL SOILS - DEEP SAMPLING RESULTS  
TABLE 3-6 (Continued)

SAMPLE NO.	B66-22	B66-32	B67-16	B67-40 *	B67D40 *	B67-60 *	B71-21 *	B71-40 *	B72-13	B72-76 *	B73-26	B73-46
<b>SEMI-VOLATILES (ug/kg)</b>												
<b>Polynuclear Aromatic Hydrocarbons</b>												
Naphthalene	780000 B	1200000	2000	180 B	180	31 B	10000	400	630	65	210000	180 J
Acenaphthylene	67000	160000 J	1400 ND	9.8 J	18 J	5.1 ND	240	52	86	3 J	20000 J	480 ND
Acenaphthene	77000	62000 J	7300	310	130	13	2400	110	320	18	61000	480 ND
Fluorene	270000	240000	3000	380	180	13	2700	97	330	18	100000	58 J
Phenanthrene	200000	710000	4200	1100	600	78	10000	380	530	58	230000 B	200 J
Anthracene	220000	230000	580 J	380	240	28	2300	71	71	2.9	32000	480 ND
Fluoranthene	430000	410000	1200 J	760 B	470 B	64 B	6800	270	410	32	180000	120 J
Pyrene	340000	370000	1000 J	580	310	50	6800	270	480	38	100000	93 J
Benzo(a)anthracene	130000 B	210000	440 J	320 B	170 B	22 B	2300	83	140	11	87000 B	52 J
Chrysene	81000	160000 J	440 J	470	200	28	800	26	11 ND	5.5	83000	480 ND
Benzo(b)fluoranthene	120000	170000 X	440 JX	260 B	140 B	18 B	3100	120	87	4.7	58000	480 ND
Benzo(k)fluoranthene	71000 B	200000 X	530 JX	180 B	100 B	12 B	1200	10	18	1.7	35000	52 J
Benzo(a)pyrene	120000 B	140000 J	200 J	330 B	150 B	21 B	2300	81	9.4	9.1	58000 B	480 ND
Dibenz(a,h)anthracene	14000	170000 ND	1400 ND	47	23	3.3	88	3.3 J	5.4 J	1.4	9500 J	480 ND
Indeno(1,2,3-cd)pyrene	53000	83000 J	1400 ND	150	88	8.5	650	260	48	4.3	20000	520
Benzo(g,h,i)perylene	47000	45000 J	1400 ND	130	58	11	87	6.2 ND	8.8 J	1.1 J	17000	320 J
TOTAL PAHs (ug/kg)	3030000	4360000	21340	5568.8	3055	402.8	51843	2213.3	3162.4	272.7	1258500	1805
TOTAL CaPAHs (ug/kg)	588000	833000	2050	1757	861	113.8	10538	583.3	308.8	37.7	308500	624
<b>Acid Extractables/Base Neutrals</b>												
2-Methylnaphthalene		270000	2400									50 J
Carbazole		81000 J	1000 J									480 ND
<b>METALS (mg/kg)</b>												
Antimony	7.8 ND	11.7 ND	14.2 ND	6.3 ND	6.5	6.1 ND	8.1 ND	5.3 ND	8.1 ND	4.9 ND	8.3 ND	10.1 ND
Arsenic	18.5	9.1	24.1	8.8	15.3	9.5	43.8	4.3	25.7	11.4	18.1	8.6
Beryllium	1.4	0.78 B	1.8 B	1	0.5 B	1.1	1	0.57 B	1.5	0.82 B	1.1	0.88 B
Cadmium	1.1 ND	1.6 ND	2 ND	0.88 ND	0.84 ND	0.87 ND	0.88 ND	0.75 ND	1.1 ND	0.88 ND	0.88 ND	1.4 ND
Chromium	32.8	20	60.8	38	23.8	38.2	33.4	20.5	41.5	28.5	31.8	25.4
Copper	21.5	8.8	61.3	6.5	4.5 B	6.7	30.6	2.5 B	17.5	4	12.8	4 B
Lead	29	1.3 ND	488	12.2	8.8	15.2	65.2	4.2	117	5.8	22.8	8.8
Manganese		153	821									111
Mercury	0.23 ND	0.18 ND	0.3	0.18 ND	0.18 ND	0.18 ND	1.2	0.16 ND	0.24 ND	0.15 ND	0.18 ND	0.15 ND
Nickel	9.1 ND	13.6 ND	19.3	9.2	7.2	10.8	12.2	6.2 ND	15.5	10.5	14	11.8 ND
Silver	1.4 ND	2.1 ND	2.5 ND	1.1 ND	1.1 ND	1.1 ND	1.1 ND	0.84 ND	1.4 ND	0.87 ND	1.1 ND	1.8 ND
Vanadium		33	104									21.7
Zinc	48.1	24	247	33.7	22.1	44.1	78.7	28.2	78.7	34.3	45.8	28.4
<b>PESTICIDES/PCBs (ug/kg)</b>												
Dieldrin		5.8 ND	7 ND									1.1 JP
4,4'-DDE		1.4 JP	7 ND									5 ND
4,4'-DDT		4.5 J	7 ND									5 ND
Arochlor-1254	4600 ND	58 ND	70 ND	37 ND	35 ND	37 ND	190 ND	32 ND	48 ND	29 ND	1900 ND	50 ND
Arochlor-1280	4600 ND	58 ND	70 ND	37 ND	35 ND	37 ND	190 ND	32 ND	48 ND	29 ND	1900 ND	50 ND
TOTAL PCBs (ug/kg)	0	0	0	0	0	0	0	0	0	0	0	0

South Carolina Aquarium Site  
Charleston, South Carolina  
INTERTIDAL SOILS - DEEP SAMPLING RESULTS  
TABLE 3-6 (Continued)

SAMPLE NO.	B74-15	B74-30	B74-35	B74D35	B74-45	B75-21	B76-21 *	B77-15	B78-30	B78-45	B79-20 *	B79D20 *
<b>SEMI-VOLATILES (ug/kg)</b>												
<b>Polynuclear Aromatic Hydrocarbons</b>												
Naphthalene	87000 B	590000	1700000 B	2500000 B	2000 B	28000	440 JBD	48000 B	210000	13000 B	540000	450000 D
Acenaphthylene	2200 JB	70000 J	130000	280000	230 B	900	210 JD	700 J	28000 ND	320	38000 J	31000 DJ
Acenaphthene	23000	38000 J	180000	140000	180	3200	1200 D	13000	93000	4700	52000 J	38000 DJ
Fluorene	25000	98000	380000 B	480000 B	860	5800	2400 D	15000 B	78000	4800 B	87000 J	86000 D
Phenanthrene	88000	350000	1200000 B	1700000 B	1800	20000	13000 D	45000 B	190000	8300 B	330000	230000 D
Anthracene	16000	140000	150000	240000	470	8700	3300 D	7900	35000	3000	78000 J	81000 D
Fluoranthene	39000 B	210000	780000 B	1000000 B	1100 B	10000	16000 BD	30000 B	110000	5000 B	210000	140000 D
Pyrene	28000 B	190000	400000 B	830000 B	830 B	8900	12000 D	24000 B	64000	3500 B	180000	120000 D
Benzofluoranthene	12000 B	94000	250000 B	380000 B	400 B	3300	8700 BD	10000 B	27000	1000 B	81000 J	55000 DJ
Chrysene	9800	92000 J	150000	230000	820	1200	7300 D	8200	22000 J	840	70000 J	45000 DJ
Benzobenzofluoranthene	9200 B	88000 XJ	110000	250000	330 B	4600	5700 BD	7800	23000 JX	550	90000 JX	74000 DX
Benzokjfluoranthene	8600 B	88000 XJ	120000 B	170000 B	230 B	1300	4000 BD	8100 B	24000 JX	380 B	100000 JX	87000 DX
Benzofluoranthene	11000 B	88000 J	190000 B	300000 B	350 B	2800	6700 BD	9800 B	7900 J	400 B	83000 J	42000 DJ
Dibenz(a,h)anthracene	1300	93000 ND	31000 B	41000 B	54	59 J	980 D	1100 B	26000 ND	45 JB	110000 ND	58000 ND
Indeno(1,2,3-cd)pyrene	8500	32000 J	84000	130000	170	840	3000 D	5700	3500 J	110	24000 J	19000 DJ
Benzofluoranthene	5700 B	8700 J	64000 B	92000 B	180	170	2800 D	4100 B	26000 ND	84 B	110000 ND	58000 ND
TOTAL PAHs (ug/kg)	329400	2157700	5848000	8783000	9804	97489	85810	235000	888400	48828	1821000	1438000
TOTAL CaPAHs (ug/kg)	56500	464000	815000	1481000	2154	13889	34380	46300	107400	3325	428000	302000
<b>Acid Extractables/Base Neutrals</b>												
2-Methylnaphthalene		140000							54000		110000	88000 D
Carbazole		32000 J							16000 J		18000 J	25000 DJ
<b>METALS (mg/kg)</b>												
Antimony	7.1 ND	20.8	6.8 ND	7 ND	4.3 ND	6.9 ND	7.8 ND	8 ND	13.3 ND	5.5 ND	23.9 ND	24.8 ND
Arsenic	23.8	14.3	16.1	27.7	9.8	26.4	27.4	27.8	14.7	13.8	22.2	24.7
Beryllium	1.5	1.7 B	1.4	1.4	0.27 B	1 B	1.2	1.4	0.88 B	0.92	1.8 B	1.9 B
Cadmium	1 ND	1.8 ND	0.84 ND	0.98 ND	0.81 ND	0.98 ND	1.1 ND	1.1 ND	1.8 ND	0.78 ND	1.9 ND	2 ND
Chromium	44.2	32.8	43.6	40.6	18	32.6	46.3	48.2	29.4	31.7	38	48.9
Copper	19.1	273	12.8	16.2	3.5	21	22.7	65.7	25	3.2 B	24.4	26.4
Lead	42.4	27.8	28.4	30.4	4.9	90.5	40.6	82.3	150	8.8	43.2	38.3
Manganese		582							327		589	589
Mercury	0.21 ND	0.19 ND	0.2 ND	0.21 ND	0.13 ND	0.35	0.24 ND	0.81	0.2 ND	0.17 ND	0.22 ND	0.25
Nickel	16.7	32	17.2	15.8	6 ND	12.8	15.2	17.7	15.5 ND	8	4.2 B	17 B
Silver	1.3 ND	2.2 ND	1.2 ND	1.2 ND	0.77 ND	1.2 ND	1.4 ND	1.4 ND	2.4 ND	0.98 ND	1.5 ND	1.5 ND
Vanadium		58.8							50.8		73.1	84
Zinc	63.8	1980	73.8	82.8	16.5	79.4	64	216	41.8	28.5	59.7	62.6
<b>PESTICIDES/PCBs (ug/kg)</b>												
Dieldrin		31 ND							22 JP		7.1 ND	7.3 ND
4,4'-DDE		31 ND							92		7.1 ND	7.3 ND
4,4'-DDT		21 JP							33 ND		7.1 ND	7.3 ND
Arochlor-1254	420 ND	310 ND	2000 ND	210 ND	23 J	210 ND	230 ND	970 ND	330 ND	33 ND	71 ND	73 ND
Arochlor-1280	420 ND	310 ND	2000 ND	210 ND	26 ND	210 ND	230 ND	970 ND	330 ND	33 ND	71 ND	73 ND
TOTAL PCBs (ug/kg)	0	0	0	0	23	0	0	0	0	0	0	0

\* Pre-selected sample

South Carolina Aquarium Site  
Charleston, South Carolina  
INTERTIDAL SOILS - DEEP SAMPLING RESULTS  
TABLE 3-6 (Continued)

SAMPLE NO.	B78-30	B79-45	B83-16 *	B83-26 *	B84-16 *	B84-32	B86-20	B86-40	B86-45	B86-66 *	B87-20 *
<b>SEMI-VOLATILES (ug/kg)</b>											
<b>Polynuclear Aromatic Hydrocarbons</b>											
Naphthalene	2300000	1000	1500000 B	4100000 BD	680000	2600000	150 J	580000 D	71	82	480000 D
Acenaphthylene	320000	65 J	30000 J	420000 D	58000	310000	780 ND	84000 DJ	5.1 J	11 J	51000 DJ
Acenaphthene	230000	68 J	370000	120000 D	110000	80000	780 ND	30000 DJ	7.9 J	11 J	27000 DJ
Fluorene	800000	300	580000	800000 D	210000	540000	97 J	110000 D	55	34 J	83000 D
Phenanthrene	1800000	760	1400000	2300000 BD	52000	170000	840	330000 D	170 B	140 B	330000 D
Anthracene	280000	220	310000	520000 D	780000	1800000	210 J	83000 D	100	21	110000 D
Fluoranthene	1200000	480	880000 B	1300000 BD	380000	820000	12000	180000 D	88 B	91	200000 D
Pyrene	780000 B	330 B	840000	810000 BD	300000	800000	950	170000 D	64	68	200000 D
Benz[a]anthracene	380000 B	170 B	300000 B	470000 BD	83000	260000	1100	81000 D	33 B	31 B	87000 D
Chrysene	500000	160	330000	430000 D	81000	140000	840	80000 DJ	42	48	78000 D
Benz[b]fluoranthene	310000	140	250000 B	320000 D	72000	170000	1700 X	74000 DX	29	29	86000 DX
Benz[k]fluoranthene	210000 B	83 B	170000 B	250000 BD	54000	140000	2400 X	85000 DX	18	21	83000 DX
Benz[a]pyrene	370000 B	160 B	260000 B	380000 BD	87000	220000	740 J	83000 DJ	33 B	34 B	58000 DJ
Dibenz[a,h]anthracene	58000	27	38000	53000 D	8400	22000	780 ND	74000 ND	5.3 J	4.7 J	73000 ND
Indeno[1,2,3-cd]pyrene	140000	50	98000	18000 ND	49000	120000	500 J	26000 DJ	13	18	30000 DJ
Benz[ghi]perylene	280000	77	110000	230000 D	28000	70000	880 J	25000 DJ	15	13	73000 ND
TOTAL PAHs (ug/kg)	9786000	4108	7345000	1.3E + 07	3033400	8462000	22417	1871000	758.3	830.7	1825000
TOTAL CaPAHs (ug/kg)	1978000	800	1445000	1803000	425400	1072000	7380	408000	174.3	181.7	434000
<b>Acid Extractables/Base Neutrals</b>											
<b>2-Methylnaphthalene</b>											
Carbazole							760 ND	120000 D			100000 D
							120 J	35000 DJ			24000 DJ
<b>METALS (mg/kg)</b>											
Antimony	6.7 ND	4.9 ND	21.7	7 ND	7.2 ND	5.8 ND	15.3 ND	10 ND	5.8 ND	5.1 ND	14.8 ND
Arsenic	14.7	12.2	41.7	21.1	20.4	11.8	22.9	13.8	7.3	4.9	22
Beryllium	1.3	0.7 B	1.3	1.2	0.11	0.65 B	1.1 B	0.68 B	1.3	0.68 B	1.5 B
Cadmium	0.84 ND	0.7 ND	1.1 ND	0.88 ND	1 ND	0.82 ND	2.2 ND	1.4 ND	0.82 ND	0.73 ND	2.1 ND
Chromium	37.1	26.5	124	29.3	31.7	22.7	43	28.7	42.9	21.3	40
Copper	14.8	3.9	175	12.4	38	10.3	39.3	6.8 B	8.3	4.1	32.8
Lead	23.7	0.85	274	20.5	519	19.9	43.7	12.3	7.1	4.1	42.6
Manganese							499	183			504
Mercury	0.22	0.15 ND	0.75	0.21 ND	0.24	0.17 ND	0.23 ND	0.15 ND	0.17 ND	0.15 ND	0.22 ND
Nickel	13.4	7.2	39.8	14.4	10.5	7.1	20.7	11.7 ND	12.2	6.3	17.2 ND
Silver	1.2 ND	0.87 ND	1.3 ND	1.2 ND	1.3 ND	1 ND	2.7 ND	1.8 ND	1 ND	0.91 ND	2.6 ND
Vanadium							78.6	30.4			73.8
Zinc	81.4	25.4	580	40.8	186	32.8	78.8	33.1	49.7	32.5	68.3
<b>PESTICIDES/PCBs (ug/kg)</b>											
<b>Dieldrin</b>											
4,4'-DDE							38 ND	5 ND			5.8 JP
4,4'-DDT							38 JP	5 ND			80
Arochlor-1254	800 ND	30 ND	2200 ND	41 ND	860 ND	1700 ND	380 ND	50 ND	22 J	31 ND	380 ND
Arochlor-1260	800 ND	30 ND	2200 ND	41 ND	860 ND	1700 ND	380 ND	50 ND	35 ND	31 ND	360 ND
TOTAL PCBs (ug/kg)	0	0	0	0	0	0	0	0	22	0	0

\* Pre-selected sample

## DATA REPORTING QUALIFIERS FOR ORGANICS

- VALUE - If the result is a value greater than or equal to the Contract Required Quantitation Limit (CRQL), report the value.
- ND or U - Indicates analyte was analyzed for but not detected.
- J - Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the sample quantitation limit but greater than zero.
- N - Indicates presumptive evidence of a compound. This flag is only used for tentatively identified compounds.
- P - This flag is used for a pesticide/Aroclor target analyte when there is greater than 25% difference for detected concentrations between the two GC columns. The lower of the two values is reported on Form I and flagged with a "P".
- C - This flag applies to pesticide results where the identification has been confirmed by GC/MS.
- B - This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action. **The results have been flagged with this qualifier even if the analyte was found in the associated blank at acceptable levels (i.e. less than the CRQL).**
- E - This flag identifies compounds whose concentrations exceed the calibration range of the GC/MS instrument for the specific analysis.
- D - This flag identifies all compounds identified in an analysis at a secondary dilution factor.
- X - Other specific flags and footnotes required to properly define the results.
- Y - The "Y" flag is used to denote pesticide/PCB compounds that could not be confirmed by GC/MS. The results from the GC/MS confirmation are included in the sample data package.

## DATA REPORTING QUALIFIERS FOR INORGANICS

### C (Concentration) Qualifiers:

B - The reported value was obtained from a reading that was less than the Contract Required Detection Limit (CRDL) but greater than or equal to the Instrument Detection Limit (IDL).

ND or U - Indicates analyte was analyzed for but not detected.

### O Qualifier:

E - The reported value is estimated because of the presence of interference.

M - Duplicate injection precision not met.

N - Spiked sample recovery not within control limits.

A or S - The reported value was determined by the Method of Standard Additions (MSA).

W - Post-digestion spike for Furnace AA analysis is out of control limits (85-115%), while sample absorbance is less than 50% of spike absorbance.

\* - Duplicate analysis not within control limits.

+ - Correlation coefficient for the MSA is less than 0.995.

### M (Method) Qualifier:

"P" - for ICP  
 "A" - for Flame AA  
 "F" - for Furnace AA  
 "PM" - for ICP when Microwave Digestion is used  
 "AM" - for Flame AA when Microwave Digestion is used  
 "FM" - for Furnace AA when Microwave Digestion is used  
 "CV" - for Manual Cold Vapor AA  
 "AV" - for Automated Cold Vapor AA  
 "CA" - for Midi-Distillation Spectrophotometric  
 "AS" - for Semi-Automated Spectrophotometric  
 "C" - for Manual Spectrophotometric  
 "T" - for Titrimetric  
 " " - where no data has been entered  
 "NR" - if the analyte is not required to be analyzed.

South Carolina Aquarium Site  
Charleston, South Carolina  
SEDIMENT SAMPLING RESULTS  
TABLE 3-7

SAMPLE NO.	S010.5	S01-03	S021.5	S023.5	S03-01	S03-03	S040.5	S04-03	S050.5	S06-03	S08-01
<b>SEMI-VOLATILES (ug/kg)</b>											
<b>Polynuclear Aromatic Hydrocarbons</b>											
Naphthalene	96 ND	2700 ND	79000	2800 DJ	530 ND	170 ND	15 J	14 J	92 ND	82 ND	300 J
Acenaphthylene	92 ND	2700 ND	21000 ND	6400 ND	510 ND	180 ND	95 ND	85 ND	88 ND	79 ND	380 J
Acenaphthene	34 J	440 J	75000	27000 D	2700	670	7.6 J	840	74 J	130	1400
Fluorene	250	320 J	53000	13000 D	1200	600	180 ND	410	300	160	4300
Phenanthrene	240	780 J	170000	28000 D	1800	2700	370	230	280	240	12000
Anthracene	2100	720 J	62000	10000 D	2100	7800	4300	45 ND	2600	1100	410 ND
Fluoranthene	1100	1800 J	98000	12000 D	1800	4500	1800	460	1200	1500	51000
Pyrene	1200	1800 J	110000	15000 D	1500	3200	2100	450	1400	1200	54000
Benzo(a)anthracene	300 B	910 J	59000	7800 D	570	1300	480 B	150 B	400 B	340 B	19000 B
Chrysene	350	830 J	47000	7300 D	580	920	610	55	380	250	9600
Benzo(b)fluoranthene	540 B	980 JX	48000 X	7000 DX	780	1800	1200 B	180	680 B	350 B	15000
Benzo(k)fluoranthene	320 B	1300 JX	60000 X	8000 DX	370	920	730 B	100 B	380 B	190 B	11000 B
Benzo(a)pyrene	480 B	580 J	38000	5500 DJ	580	1400	1000 B	140 B	580 B	320 B	18000 B
Dibenz(a,h)anthracene	44 B	2700 ND	3700 J	970 DJ	58 J	160	83 B	20 J	55 B	27 B	2100
Indeno(1,2,3-cd)pyrene	170	2700 ND	5500 J	1700 DJ	140 J	810	620	69	260	130	8800
Benzo(g,h,i)perylene	160	2700 ND	6300 J	720 DJ	220	700	680	65	230	120	7400
TOTAL PAHs (ug/kg)	7288	10320	912500	147580	14298	27280	13805.5	3183	8819	6057	214380
TOTAL CaPAHs (ug/kg)	2184	4580	259200	38270	3078	7310	4733	694	2755	1607	83800
<b>Acid Extractables/Base Neutrals</b>											
2-Methylnaphthalene		2700 ND	58000	15000 D							
Carbazole		2700 ND	7500 J	6400 ND							
<b>METALS (mg/kg)</b>											
Antimony	11 ND	20.8 ND	17.2 ND	16.3 ND	12.2 ND	9.7 ND	11.7 ND	10 ND	10.9 ND	9.5 ND	9.1 ND
Arsenic	14.7	18.6	34.1	17.8	21	46.6	17.5	18.5	15.5	17.5	19.8
Beryllium	0.64 B	1.8 B	1.8 B	1.5 B	0.64 B	0.95 B	0.98 B	1.1 B	0.97 B	1.3 B	1.1 B
Cadmium	1.5 ND	2.9 ND	2.4 ND	2.3 ND	1.7 ND	1.4 ND	1.8 ND	1.4 ND	1.5 ND	1.3 ND	1.3 ND
Chromium	28.3	49.7	28.9	41.8	54.3	62.4	38.3	62.6	31.8	49.4	44.7
Copper	11.3	24.8	48.5	38.9	30.1	37.1	15.4	38.5	18.9	27.8	36.6
Lead	34.7	28.6	36.4	68.2	41.4	62.4	31	75.7	42.4	35.7	58.6
Manganese		729	224	475							
Mercury	0.33 ND	0.31 ND	20.5	0.8	0.37 ND	0.28 ND	0.35 ND	0.27 ND	0.33 ND	0.28 ND	0.26
Nickel	12.8 ND	29.9	20 ND	19 ND	15.5	22.4	15.1	16.7	12.7 ND	15.8	20.7
Silver	1.9 ND	3.7 ND	3 ND	2.9 ND	2.2 ND	1.7 ND	2.1 ND	1.8 ND	1.9 ND	1.7 ND	1.6 ND
Vanadium		64.2	47.1	74.7							
Zinc	46.9	101	75.9	105	81	121	69	159	59.7	87.4	108
<b>PESTICIDES/PCBs (ug/kg)</b>											
Dieldrin		10 ND	42 ND	2.7 JP							
4,4'-DDE		1.8 J	35 JP	7.9 ND							
4,4'-DDT		10 ND	7.9 JP	2.5 JP							
Arochlor-1254	330 ND	100 ND	420 ND	79 ND	740 ND	580 ND	69 ND	6000 ND	64 ND	290 ND	5400 ND
Arochlor-1260	330 ND	100 ND	420 ND	79 ND	740 ND	580 ND	69 ND	6000 ND	64 ND	290 ND	5400 ND
TOTAL PCBs (ug/kg)	0	0	0	0	0	0	0	0	0	0	0

South Carolina Aquarium Site  
Charleston, South Carolina  
SEDIMENT SAMPLING RESULTS  
TABLE 3-7 (Continued)

SAMPLE NO.	S082.5	S07-01	S07-03	S080.5	S08-03	S08D03	S080.5	S08-03	S100.5	S10-03	S110.5
<b>SEMI-VOLATILES (ug/kg)</b>											
<b>Polynuclear Aromatic Hydrocarbons</b>											
Naphthalene	380 ND	610 J	380 ND	200 ND	14000	9400	12 J	74 J	90 ND	160 ND	150 ND
Acenaphthylene	360 ND	720 ND	370 ND	190 ND	3100 J	3700 ND	74 ND	760 ND	87 ND	160 ND	150 ND
Acenaphthene	2400	830	4000	140 J	70000	11000	34 J	480 J	78 ND	35 J	77 J
Fluorene	1800	1100 J	3500	740	110000	24000	92 J	1100 J	150 ND	86 J	240 J
Phenanthrene	730	14000	720	1700	34000	7300	1000	3800	230	260	2400
Anthracene	4100	40000	2000	4700	180000	16000	39 ND	6700	47 ND	120	78 ND
Fluoranthene	3800	25000	1700	2200	160000	31000	1100	61000	380	45	500
Pyrene	3400	23000	1700	2600	140000	26000	3100	40000	720	320	3000
Benzo(a)anthracene	1200	9800	880	890	55000 B	11000 B	680 B	14000 B	190 B	98 B	1000
Chrysene	880	7000	470	1100	48000	7000	1500	8600	170	160	1300
Benzo(b)fluoranthene	1700	12000	800	2000	47000 B	9800 B	1100	9400	270	49	2200
Benzo(k)fluoranthene	730	6900	120	910	27000 B	7000 B	780 B	5700 B	190 B	59 B	1000
Benzo(a)pyrene	1200	9800	640	1200	48000 B	10000 B	1100 B	8300 B	270 B	90 B	1400
Dibenz(a,h)anthracene	170 B	1300 B	82 JB	130	6700 B	1200 B	120	860	33	10 J	150
Indeno(1,2,3-cd)pyrene	900	7200	430	700	220000	6100	360	2800	120	44 ND	560
Benzo(g,h,i)perylene	660	5100	280	570	15000	3800	400	2800	140	61	770
TOTAL PAHs (ug/kg)	23780	162340	17132	19680	1186800	180600	11378	165714	2713	1393	14597
TOTAL CaPAHs (ug/kg)	6780	52800	3222	7030	450700	52100	5640	49680	1243	466	7610
<b>Acid Extractables/Base Neutrals</b>											
<b>2-Methylnaphthalene</b>											
<b>Carbazole</b>											
<b>METALS (mg/kg)</b>											
Antimony	11 ND	8.2 ND	8.9 ND	11.5 ND	6.6 ND	8.9 ND	8.6 ND	8.9 ND	10.4 ND	9.3 ND	8.8 ND
Arsenic	38.4	41.4	35.9	24.6	14.6	16.7	42.7	26.3	17.2	24.9	13.6
Beryllium	1 B	1.1 B	1.3	0.63 B	0.89 B	1.8	1.2 B	1.2 B	0.56 B	1.2 B	0.66 B
Cadmium	1.1 ND	1.2 ND	1.3 ND	1.6 ND	0.83 ND	1.3 ND	1.2 ND	1.3 ND	1.5 ND	1.3 ND	1.2 ND
Chromium	54.4	54.7	53.2	49.8	17	40	51.1	60.5	49.4	54.8	51.6
Copper	41.4	59.8	44.7	30.5	42.2	88.6	40.8	44.3	34	36.3	48.2
Lead	56	105	64.7	62.8	117	138	56.8	62.6	75.6	48.8	78
Manganese											
Mercury	0.47	0.38	0.27 ND	0.33 ND	0.32	0.28	0.24 ND	0.34	0.28 ND	0.25 ND	0.24 ND
Nickel	23.7	27.5	16.9	22.3	9.3	14.8	17.7	20.3	15.6	16.8	20.8
Silver	2 ND	1.5 ND	1.6 ND	2 ND	1.2 ND	1.6 ND	1.5 ND	1.6 ND	1.8 ND	1.6 ND	1.6 ND
Vanadium											
Zinc	150	174	138	96.4	139	391	107	170	91	89.7	123
<b>PESTICIDES/PCBs (ug/kg)</b>											
<b>Dieldrin</b>											
<b>4,4'-DDE</b>											
<b>4,4'-DDT</b>											
Arochlor-1254	530 ND	510 ND	540 ND	690 ND	400 ND	540 ND	1100 ND	270 ND	620 ND	2800 ND	530 ND
Arochlor-1280	530 ND	410 J	540 ND	690 ND	400 ND	540 ND	1100 ND	270 ND	620 ND	2800 ND	530 ND
TOTAL PCBs (ug/kg)	0	410	0	0	0	0	0	0	0	0	0

**South Carolina Aquarium Site  
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SEDIMENT SAMPLING RESULTS  
TABLE 3-7 (Continued)**

SAMPLE NO.	S11-2.5	S120.5	S12-03	S130.5	S13-03	S140.5	S14-03	S150.5	S15-03	S160.5	S18-03
<b>SEMI-VOLATILES (ug/kg)</b>											
<b>Polynuclear Aromatic Hydrocarbons</b>											
Naphthalene	1200 ND	87 ND	350 J	39 J	1800 J	400 ND	550 DJ	.210 J	750 J	21 J	120 J
Acenaphthylene	150 J	84 ND	120 J	150 ND	3800 J	380 ND	580 DJ	380 ND	1800 J	25 J	330 J
Acenaphthene	280 J	87 J	5300	480	28000	660	8800 D	1200	24000	38 J	1500
Fluorene	160 J	360	2600	220 J	14000	430 J	3800 D	340 J	18000	180	1400
Phenanthrene	580 J	580	2300	1100	55000	4200	12000 D	1800	82000	890	4400
Anthracene	320 J	5800	16000	2000	20000	1400	3300 D	350	51000	43 ND	3400
Fluoranthene	2100	2100	15000	2400	40000	14000	12000 D	3800	41000	1400	6000
Pyrene	1700	3100	13000	2800	42000	27000	11000 D	5200	37000	1800	4000
Benzo(a)anthracene	1000 J	800 B	4800 B	1200 B	22000	7200 B	5700 D	1700 B	15000 B	750 B	2800
Chrysene	1000 J	770	3300	950	20000	5500	5000 D	1100	10000	870	2400
Benzo(b)fluoranthene	1200 X	1700 B	4300 B	1200	12000	4800	5800 D	1800	12000 B	1200	2400
Benzo(k)fluoranthene	1600 X	1100 B	2700 B	730 B	13000	3400 B	7300 DX	1000 B	7000 B	770 B	830 J
Benzo(a)pyrene	780 J	1200 B	4800 B	1300 B	18000	4500 B	3200 DX	1700 B	13000 B	1100 B	1300
Dibenzo(a,h)anthracene	1200 ND	140 B	520 B	140	2800 J	440	2800 ND	210	1400 B	130	250 J
Indeno(1,2,3-cd)pyrene	250 J	900	2200	460	5600 J	1400	890 DJ	750	4100	460	640 J
Benzo(g,h,i)perylene	180 J	820	2100	540	4500 J	1400	370 DJ	810	4900	470	590 J
TOTAL PAHs (ug/kg)	11260	19437	79280	15358	299900	78330	78170	22170	322850	10102	31980
TOTAL CaPAHs (ug/kg)	5830	6710	22520	5980	91200	27240	27680	8280	62500	5280	10220
<b>Acid Extractables/Base Neutrals</b>											
2-Methylnaphthalene	1200 ND				1400 J		490 DJ				1100 ND
Carbazole	1200 ND				11000 ND		2800 ND				1100 ND
<b>METALS (mg/kg)</b>											
Antimony	23.7 ND	10.2 ND	9.2 ND	9.1 ND	14.9 ND	9.1 ND	18.7 ND	8.8 ND	7.4 ND	9.4 ND	22.1 ND
Arsenic	17.6	23.6	24.3	24.4	17.8	21.1	18.8	27	39.2	24.4	20
Beryllium	1.3 B	0.54 B	1.5	1.1 B	1.8 B	0.58 B	1.1 B	1.2 B	0.94 B	0.94 B	1.3 B
Cadmium	3.3 ND	1.4 ND	1.3 ND	1.3 ND	2.1 ND	1.3 ND	2.8 ND	1.3 ND	1 ND	1.3 ND	3.1 ND
Chromium	48.2	51.9	41.5	55.2	43.3	80	53.7	66.3	29.2	57.2	64
Copper	31.2	48.2	43.5	48.1	28	83.3	59.7	72	204	90.8	95.8
Lead	90.1	89.9	142	74.1	24.2	150	244	207	103	146	80.6
Manganese	405				275		434				545
Mercury	0.38	0.29 ND	0.32	0.55	0.82	0.25 ND	0.71	0.6	0.57	0.42	1
Nickel	37.5	16	13.6	23.9	22.9	18	26.9	30.3	8.8 ND	32.1	34.5
Silver	4.2 ND	1.8 ND	1.6 ND	1.8 ND	2.8 ND	1.8 ND	3.3 ND	1.8 ND	1.3 ND	1.7 ND	3.9 ND
Vanadium	85				55.2		89.7				85.1
Zinc	89.8	130	270	128	93.1	219	310	280	141	188	180
<b>PESTICIDES/PCBs (ug/kg)</b>											
Dieldrin	12 ND				14 P		1 JP				1.7 JP
4,4'-DDE	1.9 JP				11 P		9.1 ND				11 ND
4,4'-DDT	12 ND				7.3 ND		15				11 ND
Arochlor-1254	130 P	81 ND	280 ND	2700 ND	73 ND	1100 ND	91 ND	11000 ND	440 ND	2900 ND	110 ND
Arochlor-1280	120 ND	81 ND	280 ND	2700 ND	73 ND	1100 ND	91 ND	11000 ND	440 ND	2900 ND	110 ND
TOTAL PCBs (ug/kg)	130	0	0	0	0	0	0	0	0	0	0

South Carolina Aquarium Site  
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SEDIMENT SAMPLING RESULTS  
TABLE 3-7 (Continued)

SAMPLE NO.	S170.6	S17-03	S181.6	S18-03	S18-0.6	S18-03	S200.6	S20-03
<b>SEMI-VOLATILES (ug/kg)</b>								
<b>Polynuclear Aromatic Hydrocarbons</b>								
Naphthalene	320 J	18 J	2800 J	120 J	400	1400 J	980 J	1300 ND
Acenaphthylene	630 ND	76 ND	5600 J	160 ND	38 J	3600 J	1800 J	1300 ND
Acenaphthene	6800	67 ND	30000	820	1100	23000	11000	6200
Fluorene	4400	9800	12000	940	260	16000	6100	7600
Phenanthrene	6500	780	68000	320	1100	49000	22000	23000
Anthracene	37000	2700	20000	3200	290	16000	8200	3400
Fluoranthene	28000	210	60000	2100	3700	44000	26000	18000
Pyrene	27000	1700	67000	2000	4800	38000	23000	19000
Benzo(a)anthracene	10000 B	600 B	38000	760 B	1800 B	26000	14000	6100 B
Chrysene	6100 B	360	31000	480	1600	23000	12000	3800
Benzo(b)fluoranthene	12000 B	620 B	32000 X	810 B	1300	14000	7100	4700
Benzo(k)fluoranthene	6800 B	370 B	41000 X	430 B	1200 B	8100 J	6100 J	3000 B
Benzo(a)pyrene	9200 B	640 B	27000	860 B	1900 B	16000	7700	4900 B
Dibenz(a,h)anthracene	1400 B	68 B	2600 J	88 B	210	2400 J	1300 J	460
Indeno(1,2,3-cd)pyrene	6300	360	6600 J	400	890	4600 J	2700 J	3400
Benzo(g,h,i)perylene	6100	280	9700 J	360	900	3800 J	2400 J	2400
TOTAL PAHs (ug/kg)	162920	18484	443100	13668	21386	286800	160180	106760
TOTAL CaPAHs (ug/kg)	49800	2988	178100	3608	6800	92000	49900	26160
<b>Acid Extractables/Base Neutrals</b>								
2-Methylnaphthalene			1500 J			1000 J	680 J	
Carbazole			11000 ND			8900 ND	6600 ND	
<b>METALS (mg/kg)</b>								
Antimony	7.6 ND	9 ND	14.9 ND	8.8 ND	9.1	18.1 ND	14.2 ND	7.7 ND
Arsenic	13.3	27.3	18.1	29.6	22.4	20.6	14.9	31.7
Beryllium	0.68 B	1.6	0.94 B	1.4	0.63 B	1.3 B	1 B	1 B
Cadmium	1.6	1.3 ND	2.1 ND	1.2 ND	1 ND	2.6 ND	2 ND	1.1 ND
Chromium	44.6	40	27	37.6	62.4	62.9	81	60.4
Copper	101	36	29	38	170	68.2	60.7	43.4
Lead	283	61.7	60.9	48.6	192	222	142	264
Manganese			262			268	328	
Mercury	0.87	0.27 ND	0.42	0.26 ND	2.3	1.1	0.74	0.63
Nickel	19.2	16	17.4 ND	13.2	16.6	22.2	21.3	16.4
Silver	1.3 ND	1.6 ND	2.6 ND	1.6 ND	1.3 ND	3.2 ND	2.6 ND	1.4 ND
Vanadium			45.9			82.4	61.1	
Zinc	686	146	96.9	142	468	344	306	169
<b>PESTICIDES/PCBs (ug/kg)</b>								
Dieldrin			18 P			3.1 JP	36 ND	
4,4'-DDE			6.8 JP			6.1 JP	6.3 JP	
4,4'-DDT			1.8 JP			8.8 ND	7.3 JP	
Arochlor-1254	450 ND	270 ND	73 ND	63 ND	430 ND	88 ND	360 ND	9000 ND
Arochlor-1260	360 J	270 ND	73 ND	63 ND	430 ND	88 ND	360 ND	9000 ND
TOTAL PCBs (ug/kg)	360	0	0	0	0	0	0	0

## DATA REPORTING QUALIFIERS FOR ORGANICS

- VALUE - If the result is a value greater than or equal to the Contract Required Quantitation Limit (CRQL), report the value.
- ND or U - Indicates analyte was analyzed for but not detected.
- J - Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the sample quantitation limit but greater than zero.
- N - Indicates presumptive evidence of a compound. This flag is only used for tentatively identified compounds.
- P - This flag is used for a pesticide/Aroclor target analyte when there is greater than 25 % difference for detected concentrations between the two GC columns. The lower of the two values is reported on Form I and flagged with a "P".
- C - This flag applies to pesticide results where the identification has been confirmed by GC/MS.
- B - This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action. **The results have been flagged with this qualifier even if the analyte was found in the associated blank at acceptable levels (i.e. less than the CRQL).**
- E - This flag identifies compounds whose concentrations exceed the calibration range of the GC/MS instrument for the specific analysis.
- D - This flag identifies all compounds identified in an analysis at a secondary dilution factor.
- X - Other specific flags and footnotes required to properly define the results.
- Y - The "Y" flag is used to denote pesticide/PCB compounds that could not be confirmed by GC/MS. The results from the GC/MS confirmation are included in the sample data package.

## DATA REPORTING QUALIFIERS FOR INORGANICS

### C (Concentration) Qualifiers:

- B - The reported value was obtained from a reading that was less than the Contract Required Detection Limit (CRDL) but greater than or equal to the Instrument Detection Limit (IDL).
- ND or U - Indicates analyte was analyzed for but not detected.

### Q Qualifier:

- E - The reported value is estimated because of the presence of interference.
- M - Duplicate injection precision not met.
- N - Spiked sample recovery not within control limits.
- A or S - The reported value was determined by the Method of Standard Additions (MSA).
- W - Post-digestion spike for Furnace AA analysis is out of control limits (85-115%), while sample absorbance is less than 50% of spike absorbance.
- \* - Duplicate analysis not within control limits.
- + - Correlation coefficient for the MSA is less than 0.995.

### M (Method) Qualifier:

- "P" - for ICP
- "A" - for Flame AA
- "F" - for Furnace AA
- "PM" - for ICP when Microwave Digestion is used
- "AM" - for Flame AA when Microwave Digestion is used
- "FM" - for Furnace AA when Microwave Digestion is used
- "CV" - for Manual Cold Vapor AA
- "AV" - for Automated Cold Vapor AA
- "CA" - for Midi-Distillation Spectrophotometric
- "AS" - for Semi-Automated Spectrophotometric
- "C" - for Manual Spectrophotometric
- "T" - for Titrimetric
- " " - where no data has been entered
- "NR" - if the analyte is not required to be analyzed.

South Carolina Aquarium Site  
Charleston, South Carolina  
**GROUNDWATER AND SURFACE WATER SAMPLING RESULTS**  
**TABLE 3-8**

SAMPLE NO.	MW-08	MW-11	MW-KA1	MWDKA1	SW-01
<b>VOLATILE ORGANICS (ug/L)</b>					
Methylene Chloride	2 BJ	10 B	3 BJ	6 BJ	2 BJ
Carbon Disulfide	9 J	4 J	8 J	3 J	10 ND
Benzene	14	2 J	10 ND	10 ND	10 ND
Toluene	5 J	1 J	10 ND	10 ND	10 ND
Ethylbenzene	5 J	5 J	4 J	3 J	10 ND
Xylene	19	15	12	11	10 ND
<b>SEMI-VOLATILES (ug/L)</b>					
<b>Polynuclear Aromatic Hydrocarbons</b>					
Naphthalene	150 D	200 D	2 J	1 J	10 ND
Acenaphthylene	50 ND	60 ND	10 ND	10 ND	10 ND
Acenaphthene	13 DJ	150 D	2 J	1 J	10 ND
Dibenzofuran	5 DJ	43 DJ	10 ND	10 ND	10 ND
Fluorene	6 DJ	45 DJ	10 ND	10 ND	10 ND
Phenanthrene	12 DJ	54 DJ	1 J	10 ND	10 ND
Anthracene	50 ND	13 DJ	10 ND	10 ND	10 ND
Fluoranthene	50 ND	11 DJ	10 ND	10 ND	10 ND
Pyrene	50 ND	10 DJ	10 ND	10 ND	10 ND
Benzo(a)anthracene	50 ND	60 ND	10 ND	10 ND	10 ND
Chrysene	50 ND	60 ND	10 ND	10 ND	10 ND
bis(2-Ethylhexyl)Phthalate	7 BDJ	14 BDJ	10 ND	2 BJ	10 ND
Benzo(b)fluoranthene	50 ND	60 ND	10 ND	10 ND	10 ND
Benzo(k)fluoranthene	50 ND	60 ND	10 ND	10 ND	10 ND
Benzo(a)pyrene	50 ND	60 ND	10 ND	10 ND	10 ND
Dibenz(a,h)anthracene	50 ND	60 ND	10 ND	10 ND	10 ND
Indeno(1,2,3-cd)pyrene	50 ND	60 ND	10 ND	10 ND	10 ND
Benzo(g,h,i)perylene	50 ND	60 ND	10 ND	10 ND	10 ND
TOTAL PAHs (ug/L)	193	540	5	4	0
TOTAL CaPAHs (ug/L)	7	14	0	2	0
<b>Acid Extractables/Base Neutrals</b>					
2-Methylnaphthalene	12 DJ	74 D	10 ND	10 ND	10 ND
Carbazole	8 DJ	34 DJ	10 ND	10 ND	10 ND
<b>METALS (ug/L)</b>					
Antimony	56.5 ND	56.5 ND	56.5 ND	61.6	56.5 ND
Arsenic	40.1	47.6	3.4 ND	10 B	10.3 B
Beryllium	1.6 B	0.4 ND	0.4 ND	0.4 ND	0.4 ND
Cadmium	4.8 ND	4.8 ND	4.8 ND	4.8 ND	4.8 ND
Chromium	73.6	6 ND	6 ND	6 ND	6 ND
Copper	13.2 B	9.4 B	2.7 ND	2.7 ND	4.3 B
Lead	48	8.1	20 ND	20 ND	20 ND
Manganese	1970	872	90	88.4	32
Mercury	0.26	0.23	0.2 ND	0.2 ND	0.2 ND
Nickel	14.3 ND	14.3 ND	14.3 ND	14.3 ND	14.3 ND
Silver	5.3 ND	5.3 ND	5.3 ND	5.3 ND	5.3 ND
Vanadium	83.6	5.3 B	4.1 ND	4.1 ND	6.2 B
Zinc	112	74.3	44.4	20.4	37.1
<b>PESTICIDES/PCBs (ug/L)</b>					
Dieldrin	0.1 ND	0.1 ND	0.1 ND	0.1 ND	0.1 ND
4,4'-DDE	0.1 ND	0.1 ND	0.1 ND	0.1 ND	0.1 ND
4,4'-DDT	0.1 ND	0.1 ND	0.1 ND	0.1 ND	0.1 ND
Arochlor-1254	1 ND	1 ND	1 ND	1 ND	1 ND
Arochlor-1260	1 ND	1 ND	1 ND	1 ND	1 ND
TOTAL PCBs (ug/L)	0	0	0	0	0

## DATA REPORTING QUALIFIERS FOR ORGANICS

- VALUE - If the result is a value greater than or equal to the Contract Required Quantitation Limit (CRQL), report the value.
- ND or U - Indicates analyte was analyzed for but not detected.
- J - Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the sample quantitation limit but greater than zero.
- N - Indicates presumptive evidence of a compound. This flag is only used for tentatively identified compounds.
- P - This flag is used for a pesticide/Aroclor target analyte when there is greater than 25% difference for detected concentrations between the two GC columns. The lower of the two values is reported on Form I and flagged with a "P".
- C - This flag applies to pesticide results where the identification has been confirmed by GC/MS.
- B - This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action. **The results have been flagged with this qualifier even if the analyte was found in the associated blank at acceptable levels (i.e. less than the CRQL).**
- E - This flag identifies compounds whose concentrations exceed the calibration range of the GC/MS instrument for the specific analysis.
- D - This flag identifies all compounds identified in an analysis at a secondary dilution factor.
- X - Other specific flags and footnotes required to properly define the results.
- Y - The "Y" flag is used to denote pesticide/PCB compounds that could not be confirmed by GC/MS. The results from the GC/MS confirmation are included in the sample data package.

## DATA REPORTING QUALIFIERS FOR INORGANICS

### C (Concentration) Qualifiers:

B - The reported value was obtained from a reading that was less than the Contract Required Detection Limit (CRDL) but greater than or equal to the Instrument Detection Limit (IDL).

ND or U - Indicates analyte was analyzed for but not detected.

### Q Qualifier:

E - The reported value is estimated because of the presence of interference.

M - Duplicate injection precision not met.

N - Spiked sample recovery not within control limits.

A or S - The reported value was determined by the Method of Standard Additions (MSA).

W - Post-digestion spike for Furnace AA analysis is out of control limits (85-115%), while sample absorbance is less than 50% of spike absorbance.

\* - Duplicate analysis not within control limits.

+ - Correlation coefficient for the MSA is less than 0.995.

### M (Method) Qualifier:

"P" - for ICP

"A" - for Flame AA

"F" - for Furnace AA

"PM" - for ICP when Microwave Digestion is used

"AM" - for Flame AA when Microwave Digestion is used

"FM" - for Furnace AA when Microwave Digestion is used

"CV" - for Manual Cold Vapor AA

"AV" - for Automated Cold Vapor AA

"CA" - for Midi-Distillation Spectrophotometric

"AS" - for Semi-Automated Spectrophotometric

"C" - for Manual Spectrophotometric

"T" - for Titrimetric

" " - where no data has been entered

"NR" - if the analyte is not required to be analyzed.

#### 4.0 SUMMARY OF ANALYTICAL DATA QUALITY REVIEW

Formal data validation of the analytical results was not included in the scope of work specified in the PSI Workplan. However, in order to verify that the data generated are valid and usable, Killam performed a data quality assessment by reviewing the non-conformance summary sheets and case narratives provided by the laboratories.

Killam reviewed each sample delivery group (SDG) for each analysis and all media. A case narrative was provided with each SDG, documenting any non-conformance items with respect to required acceptance criteria for surrogate recoveries, internal standards recoveries, LCS recoveries, method blank results and holding times, etc. The data quality review was not performed on an individual sample basis. However, in certain cases where a sample had been diluted or re-extracted, the individual sample was reviewed in order to determine the appropriate results for reporting purposes.

Tables 4-1 through 4-7 list the SDG and any comments with regard to QA/QC non-conformance for that SDG. The tables are arranged by analyses for soil (BTEX, PAHs, PP Metals, PCBs, TAL/TCL, and dioxins) and groundwater (TAL/TCL), respectively.

The most common non-conformance issue identified was low surrogate recovery or an inability to quantitate surrogate recovery. This was primarily due to either dilution of the sample, or severe matrix interference due to the composition of the samples. Low Matrix Spike/Matrix Spike Duplicate recoveries due to severe matrix interference were also a common problem noted in the data quality review.

Generally, with the exception of samples which were re-extracted outside of the required holding times, the data quality review revealed non-conformances which appear to be typical for a data package of this size. No data have been rejected, but certain samples which have been called out specifically in the following discussion should only be accepted as accurate and/or precise at the discretion of the user. The data quality is considered acceptable for the current purpose of qualitatively determining the risk of release of contaminants to the environment as a result of the construction of the aquarium.

Please note that the following discussion is not intended to replace a formal and complete data validation effort as described by the EPA in the documents **Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses**, (July 1, 1988) and **National Functional Guidelines for Organic Data Review**, (USEPA Contract Laboratory Program, December 1990, revised June, 1991).

##### 4.1 Benzene, Toluene, Ethylbenzene, Xylenes Data

All BTEX samples were analyzed within the prescribed holding time. Several SDGs had surrogate recoveries outside of limits due to matrix interference. A number of SDG packages

had bromofluorobenzene (BFB) recoveries that were outside of acceptance limits in the primary and/or confirmation analyses of certain samples.

In some SDG packages, second column analyses were required to confirm the presence of one or more target analytes. One to four Target Compound List (TCL) analytes were confirmed at concentrations above the CRQL. The presence of these analytes was confirmed by two dissimilar analytical columns, and in some SDGs, the quantitated amounts of analytes did not agree within 25% between the columns.

Surrogate recoveries which were outside of limits appear to be the main concern for the BTEX data. Generally, the data appears to be accurate and in usable condition. For a more complete listing of the data quality issues for each SDG package, please refer to Table 4-1.

#### 4.2 Polynuclear Aromatic Hydrocarbons Data

Several SDG packages had extraneous peaks in their blanks. This peak was also present in the instrument blanks as a "shoulder". The laboratory identified the peaks as laboratory artifacts.

Several of the SDG packages for PAHs contained samples which required dilutions to avoid saturation of the detectors due to high levels of target analytes. Surrogate recoveries for these samples were either low or could not be quantitated due either to severe matrix interference or to dilution and masking of the surrogates.

Several of the SDG packages had matrix spikes (MS) and matrix spike duplicates (MSD) for which recoveries of all spiking compounds could not be accurately identified or quantitated. In most cases, the laboratory extracted and analyzed a blank sample with the samples which passed all spike recovery and surrogate recovery criteria.

A few of the SDG packages had method blanks which contained target analytes above the quality control acceptance criteria. The laboratory's interpretation of the contamination requirement for method blanks in any method is that no compound should be found at a concentration above the quantitation limit unless otherwise specified by the appropriate contract. In the SDGs where the method blanks contained target analytes above these criteria, the associated method blank concentrations were very low. Additionally, a few SDG packages had method blanks which contained target analytes that were below the quality control criteria.

In several of the SDG packages, when a method blank failed QC acceptance criteria for the presence of target analytes, a second extraction was performed on the associated samples in order to obtain a contaminant free blank. In certain cases, the second extraction was performed outside of the holding time. The results obtained from the second extraction of the sample have been reported in the data summary tables in this report. The following samples have been noted to exceed the holding time on re-extraction: B48-02, B64-04, B65-02, B65-04, B65-12, B67-40, B67D40, B76-21, B84-32 and B87-04. It is possible that the exceedence of the holding time

may have had some effect on the results. Please refer to Table 4-2 for more detailed comments on data quality for each SDG.

### **4.3 Priority Pollutant Metals Data**

Analyte determination utilizing the Method of Standard Additions occurred for some sample results in several SDG packages. A slight matrix-related interference was identified in several samples within some of the SDGs. The sample matrix spike was found to be outside CLP control limits in several SDG packages. All samples were prepared and analyzed within the specified holding times. Please refer to Table 4-3 for a description of data quality issues for each SDG package.

### **4.4 PCB Data**

In several SDG packages, dilutions were required for samples in which non-target analytes were present at high levels. Therefore, the surrogate concentrations were reduced, and masked by the other analytes, and the surrogate recovery could not be quantitated. Matrix interference also precluded surrogate recovery in samples in several SDG packages.

In certain samples in the SDG packages, second column analyses were required to confirm the presence of one or more target analytes. In some of these samples, the quantitated amounts did not agree within 25% of each other.

Two samples (B75-02 and B75-21), were re-extracted outside of holding time since all QC criteria had not been met. In other SDGs the surrogate recoveries were out of limits due to matrix interference. With the exception of the two samples listed above, the data appears to be usable. Please refer to Table 4-4 for a complete listing of the data quality issues for each SDG package.

### **4.5 TAL/TCL Data**

#### **4.5.1 Inorganics**

In several SDG packages, the sample matrix spike was outside the CLP control limits. A slight matrix interference was identified in certain samples in some SDG packages. In some SDG packages, the sample matrix duplicate was out of control limits. The Method of Standard Additions was used to calculate the values of some metals in certain SDG packages. Table 4-5A lists the data quality issues for the Inorganics portion of the TAL/TCL analyses for individual SDG packages.

## 4.5.2 Organics

### 4.5.2.1 Volatiles Fraction

Methylene chloride and acetone were found in a number of method blanks for the volatile organic fractions. These volatile organic contaminants are laboratory artifacts and are flagged with a "B" when they are detected in sample results. One SDG package had one sample which missed the CLP 10 day holding time but was within the 14 day technical holding time. This sample had a number of ketone, halogenated alkane and aromatic TCL analytes identified above the CRQL. Please refer to Table 4-5B for a more detailed listing of non-conformances for each SDG package.

### 4.5.2.2 Semi-volatiles Fraction

In several SDG packages, the standard for initial calibration was saturated (exceeded the instrument's range). Some of the surrogate recoveries in several SDG packages were low, due either to dilutions which had been performed, or to matrix interferences. Two samples (B37-08 and B65D25) failed to meet surrogate recovery criteria and internal standard response criteria. These samples were re-extracted outside of holding times. The analyses of the second extractions met all quality control criteria. Please refer to Table 4-5B for a more detailed listing of non-conformance information for each SDG package.

### 4.5.2.3 Pesticides/PCBs Fraction

Several SDG packages had surrogate recoveries outside of limits due to matrix interference or dilution of samples. Some method blanks had targeted analytes present, but at levels below the acceptance criteria. In some SDG packages, the MS/MSD recovery was outside of limits due to matrix interference. In one SDG, the recoveries of the advisory surrogate DCB failed quality control in the initial extracts of two samples (RDT218 and SPT218). These samples were re-extracted outside of the prescribed holding time. Please refer to Table 4-5B for a complete listing of non-conformances for each SDG package.

## 4.6 Dioxin Data

One SDG package had a soil blank which was re-analyzed due to the presence of 2,3,7,8-TCDF above the target detection limits. In one SDG package, one sample was re-cleaned due to low levels cross-contamination with a matrix spike sample. No other non-conformances were noted for this data group. Please refer to Table 4-6 for a complete listing of data quality review comments for each SDG.

## **4.7 Groundwater and Surface Water Data**

### **4.7.1 Inorganics**

The sample matrix spike was outside CLP limits for nine metals. A slight matrix interference for one or more metals was identified in seven samples. Table 4-7 lists these items for the Inorganics fraction of the groundwater and surface water SDG package(s).

### **4.7.2 Organics**

No non-conformances were observed for the volatiles fraction of these data. For the semi-volatiles, two standards were saturated. The laboratory provided dual spectra for these compounds to demonstrate that there is no mass spectral distortion. For the pesticides/PCB fraction, some surrogate recoveries were above the internal minimum acceptance criteria. Refer to Table 4-7 which lists the individual non-conformance issues for the groundwater and surface water data.

KEY TO ABBREVIATIONS FOR TABLES 4-1 THROUGH 4-7

BFB	-	bromofluorobenzene
CRQL	-	contact required quantitation limit
TCL	-	target compound list
MS	-	matrix spike
MSD	-	matrix spike duplicate
DCB	-	decachlorobiphenyl
RPD	-	relative percent difference
TCX	-	tetrachloro-m-xylene
QC	-	quality control
CLP	-	contract laboratory program
MSA	-	method of standard additions

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**BENZENE, TOLUENE, ETHYLBENZENE & XYLENES**  
**DATA QUALITY REVIEW**  
**TABLE 4-1**

SDG No.	Data Quality Evaluation Comments
415	No non-conformances reported.
409	The surrogate recovery in one sample failed advisory acceptance criteria. The surrogate failures in another sample were attributed to a sample matrix effect.
411	No non-conformances reported.
412	Recoveries of bromofluorobenzene (BFB) failed advisory recovery criteria in the initial and confirmation analyses of two samples.
417	No non-conformances reported.
416	These samples had two analyses reported which confirmed failing surrogate recoveries due to sample matrix effects. One sample had surrogate failure, but the recovery criteria was advisory and no target compounds were present above CRQL.
421	No non-conformances reported.
418	Two samples had the presence of analytes confirmed; however, the quantitated amounts of each analyte did not agree within 25% between the analytical columns. Surrogates did not meet recovery criteria in three samples. The recoveries of BFB exceeded the upper acceptance limits in the primary and confirmation analysis of one sample. The recoveries of BFB fell below the lower acceptance limit in the primary and confirmation analyses of one sample, and in the confirmation analyses only of another sample.
423	Surrogate recovery failures due to sample matrix effects are confirmed in three samples.
424	No non-conformances reported.
426	The quantitated amounts of targeted analytes did not agree within 25% between the columns in two samples. The recoveries for BFB fell below the lower acceptance limit in the confirmation analysis of one sample. The recovery of BFB exceeded the acceptance limit in the primary analysis of one sample. The acceptance of BFB in the matrix spike fell slightly below the lower acceptance limit.
427	No non-conformances reported.

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**TABLE 4-1 (continued)**

SDG No.	Data Quality Evaluation Comments
428	No non-conformances reported.
425	The surrogate failed acceptance criteria in the first analysis of one sample, but met criteria in the reanalysis. In the second analysis of one sample, there was a surrogate recovery failure.
419	No non-conformances reported.
435	The recoveries of the BFB were slightly below the acceptance limit for the initial and confirmation analyses of nine samples. The recovery of BFB was slightly below the acceptance criteria in the primary analysis of one sample.
433	No non-conformances reported.
434	The recovery of BFB did not meet recovery criteria in the primary and confirmation analyses of two samples. BFB failed recovery criteria in the primary analyses of two samples.
436	The recovery of BFB was below the lower acceptance limit in the primary and/or confirmation analyses of five samples. The RPD value for benzene failed acceptance criteria. The recovery of BFB failed acceptance criteria in the MS and MSD.
446	No non-conformances reported.
437	The recovery of benzene was flagged as an outlier in both the MS and MSD. The RPD of benzene was flagged as an outlier in the comparison of the MS and MSD.
447	The recovery for BFB failed acceptance criteria in the primary analysis of one sample. The recovery of BFB was below the lower acceptance limit in the matrix spike duplicate.
441	The recovery for BFB fell below the lower acceptance limit in the primary and/or confirmation analyses of three samples. The surrogate recoveries were below the lower acceptance limit for the MS and MSD.

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**TABLE 4-2**

SDG No.	Data Quality Evaluation Comments
213PN	The associated method blank contained targeted analytes above detection limits.
288PN	Fourteen samples required dilutions in order to avoid saturation of the detectors. Of these diluted samples, no surrogate recoveries were available for ten samples. Due to high dilutions, recoveries in all spiking compounds in the matrix spike and its duplicate could not be accurately identified or quantitated. A blank spike was extracted and analyzed and it passed all spike and surrogate recovery criteria.
214PN	No non-conformances reported.
212PN	The associated method blank contained an extraneous peak which was within the retention time window of benzo(a)pyrene. This peak was also present in the instrument blanks and in the initial standards as a shoulder on the right side of the benzo(a)pyrene peak. Based on this, the peak was determined to be a laboratory artifact.
227PN	Fourteen samples required dilutions in order to avoid saturation of the detectors. Of these diluted samples, no surrogate recoveries were available for eight samples. One sample had no surrogate recovery due to severe matrix interference. Due to matrix interference, recoveries for all spiking compounds in the matrix spike and its duplicate could not be accurately identified or quantitated. A blank spike was extracted and analyzed with the samples which passed all spike and surrogate recovery criteria.
229PN	Twelve samples required dilutions in order to avoid saturation of the detectors. Of these diluted samples, no surrogate recoveries were available for ten samples. Due to the high level of dilution, recoveries for all spiking compounds in the matrix spike and its duplicate, could not be accurately identified or quantitated. A blank spike was extracted and analyzed with the samples which passed all spike and surrogate recovery criteria.
215PN	Benzo(k)fluoranthene was present in the associated method blank at levels above the quality control criteria.
230PN	Eleven samples required dilutions in order to avoid saturation of the detectors. Of these diluted samples, no surrogate recoveries were available for six samples due to severe matrix interference or the surrogate being diluted out. Due to the high level of target analytes and matrix interference, and the dilutions, recoveries for all spiking compounds in the matrix spike and its duplicate, could not be accurately identified or quantitated. A blank spike was extracted and analyzed with the samples which passed all spike and surrogate recovery criteria.

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**DATA QUALITY REVIEW**  
**TABLE 4-2 (continued)**

SDG No.	Data Quality Evaluation Comments
231PN	Fourteen samples required dilutions in order to avoid saturation of the detectors. Of these diluted samples, no surrogate recoveries were available for five samples due to severe matrix interference or the surrogate being diluted out. Four samples and the associated method blank had the incorrect amount of surrogate added to the samples. (The laboratory technician inadvertently added five times the normal surrogate amount.) Due to the high level of target analytes and matrix interference, and the dilutions, recoveries for half the spiking compounds in the matrix spike and its duplicate, could not be accurately identified or quantitated. A blank spike was extracted and analyzed with the samples which passed all spike and surrogate recovery criteria.
216PN	No non-conformances reported.
217PN	No non-conformances reported.
232PN	Many of the samples required dilutions to avoid saturation of the detectors. Several of the samples had no surrogate recoveries due to severe matrix interference or the surrogates being diluted out. Due to the high levels of dilution, the compounds in the matrix spike and its duplicate could not be accurately identified or quantitated. A blank spike was extracted and analyzed with the samples which passed all spike recovery and surrogate recovery criteria. One of the method blanks failed quality control acceptance criteria for target analytes.
218PN	A second extraction was performed to obtain a contaminant free blank. This extraction was performed past the holding time. The associated method blank contained a peak within the retention time window of benzo(k)fluoranthene. This peak was also present as a shoulder on the right side of the benzo(k)fluoranthene peak in the initial and continuing calibrations. This peak is believed to be a laboratory artifact.
234PN	Two samples required dilutions to avoid saturation of the detectors. of the diluted samples, only one sample had no surrogate recovery due to severe matrix interference. Due to severe matrix interference, recoveries for the majority of spiking compounds could not be accurately identified or quantitated. A blank spike was extracted and analyzed with the samples which passed all spike recovery and surrogate recovery criteria. One of the method blanks failed surrogate recovery criteria.

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**DATA QUALITY REVIEW**  
**TABLE 4-2 (continued)**

SDG No.	Data Quality Evaluation Comments
233PN	Several samples required dilutions to avoid saturation of the detectors due to high levels of target analytes. Of the diluted samples, no surrogate recoveries were available in several of them due to severe matrix interference or the surrogates being diluted out. Due to the high levels of dilution, recoveries for the spiking compounds in the matrix spike and its duplicate could not be accurately identified or quantitated. A blank spike was extracted and analyzed with the samples which passed all spike and surrogate recovery criteria.
235PN	Dilutions were required for all samples in order to avoid saturation of the detectors. Surrogate recoveries for all samples except two, could not be accurately quantitated due to the dilution level or matrix interference. Due to the level of dilution, recoveries for the spiking compounds could not be accurately identified or quantitated. A blank spike was extracted and analyzed with samples which passed all spike recovery and surrogate recovery criteria.
219PN	One sample had target analytes present above acceptable levels in its associated blank. This sample was re-extracted outside of holding time requirements. This second blank also failed to meet acceptance criteria for the presence of target analytes. A third blank was not extracted since no more sample was available.
236PN	One of the method blanks failed QC acceptance criteria for the presence of target analytes. In order to obtain a contaminant free blank, a second extraction was performed outside of the holding time on all the associated samples. Dilutions were required for the majority of samples in order to avoid saturation of the detectors. Of the diluted samples, several samples did not meet surrogate recoveries due to matrix interference or the dilution level. No spike recoveries were available due to matrix interference from the original sample. A blank spike was prepared and analyzed with the samples which passed all QC acceptance criteria.
237PN	One of the method blanks failed QC acceptance criteria for the presence of target analytes. In order to obtain a contaminant free blank, a second extraction was performed outside of the holding time on all the associated samples. Dilutions were required for the majority of samples in order to avoid saturation of the detectors. Of the diluted samples, several samples did not meet surrogate recoveries due to matrix interference or the dilution level. No spike recoveries were available due to matrix interference from the original sample. A blank spike was prepared and analyzed with the samples which passed all QC acceptance criteria.

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**DATA QUALITY REVIEW**  
**TABLE 4-2 (continued)**

SDG No.	Data Quality Evaluation Comments
238PN	One of the method blanks failed QC acceptance criteria for the presence of target analytes. In order to obtain a contaminant free blank, a second extraction was performed outside of the holding time on all the associated samples. Dilutions were required for the majority of samples in order to avoid saturation of the detectors. Of the diluted samples, several samples did not meet surrogate recoveries due to matrix interference or the dilution level. No spike recoveries were available due to matrix interference from the original sample. A blank spike was prepared and analyzed with the samples which passed all QC acceptance criteria.
239PN	One of the method blanks failed QC acceptance criteria for the presence of target analytes. In order to obtain a contaminant free blank, a second extraction was performed outside of the holding time on all the associated samples. Dilutions were required for the majority of samples in order to avoid saturation of the detectors. Of the diluted samples, several samples did not meet surrogate recoveries due to matrix interference or the dilution level. No spike recoveries were available due to matrix interference from the original sample. A blank spike was prepared and analyzed with the samples which passed all QC acceptance criteria.
220PN	One of the method blanks failed QC acceptance criteria for the presence of target analytes. Due to contamination, the associated samples were re-extracted outside of holding time requirements. The re-extract blank also failed QC acceptance criteria for the presence of target analytes. A third extraction was unable to be performed since no sample remained.

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**PRIORITY POLLUTANT METALS**  
**DATA QUALITY REVIEW**  
**TABLE 4-3**

SDG No.	Data Quality Evaluation Comments
193200	The sample matrix spike was found to be outside CLP control limits for three metals. The sample matrix duplicate was out of control limits for one metal. A slight matrix related interference was present for one to three analytes in sixteen samples. The Method of Standard Additions (MSA) was used to calculate the values of three metals.
193201	The sample matrix spike was reprepared and reanalyzed and found to be outside control limits for five metals. The sample matrix duplicate was out of control limits for two metals. A slight matrix interference was identified in one to two metals in nineteen samples. The MSA was used to calculate the values of three metals.
193202	The sample matrix spike was found to be outside CLP control limits for two metals. The sample matrix duplicate was out of control limits for one metal. Two samples had metals in which the associated analytical spike recovery was less then 40% indicating that a severe physical or chemical interference was present in the matrix. A slight matrix related interference was identified in eighteen samples for two analytes. The MSA was used to calculate the values of four analytes.
192200	A slight matrix interference was identified in one sample for one metal.
193203	The sample matrix spike was found to be outside CLP control limits for five metals. The sample matrix duplicate was out of control limits for two metals. The spike recovery associated with four metals in five samples was less than 40%. A slight matrix interference was identified in fifteen samples. The MSA was required to calculate the values for two metals in sixteen samples.
193204	The sample matrix spike was found to be outside of CLP control limits for three metals. The sample matrix duplicate was out of control limits for six metals. The spike recovery associated with three metals in four samples was less than 40%. A slight matrix related interference was identified in thirteen samples.
193205	The sample matrix spike was found to be outside of CLP control limits for four metals. In one sample, the spike recovery was less than 40% for arsenic. A slight matrix interference was identified in twenty samples for two metals. The sample matrix duplicate was out of control limits for one metal. The MSA was used to calculate the value of two metals in eighteen samples.
192204	A slight matrix interference was identified in for one metal in two samples.

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**DATA QUALITY REVIEW**  
**TABLE 4-3 (continued)**

SDG No.	Data Quality Evaluation Comments
193206	The sample matrix spike was outside of control limits for four metals. The sample matrix duplicate was out of control limits for five metals. The spike recovery associated with selenium in two samples was less than 40%. A slight matrix interference was identified in sixteen samples. The MSA was used to calculate the values for two metals in sixteen samples.
192205	A slight matrix interference was identified in two samples.
193207	The sample matrix spike was outside of CLP control limits for four metals. A slight matrix interference was identified in two samples. The MSA was used to calculate the value for lead in one sample.
193208	The sample matrix spike was outside of CLP control limits for four metals. A slight matrix interference was identified in twenty samples. The MSA was used to calculate the values for one analyte in nine samples.
192206	No non-conformances reported.
193209	The sample matrix spike was found to be outside of CLP control limits for five metals. The sample matrix duplicate was found to be out of control limits for three analytes. A slight matrix interference was identified in nineteen samples. The MSA was used to calculate the values for three metals in seven samples.
193210	The matrix spike was found to be outside of CLP control limits for two metals. A slight matrix interference was identified in fifteen samples. The MSA was used to calculate the value of arsenic in nine samples.
192207	A slight matrix interference was identified in two samples for two metals.
193211	The sample matrix spike was found to be outside CLP control limits for five metals. The sample matrix duplicate was out of control limits for two analytes. The spike recovery associated with four metals in fourteen samples was less than 40%. A slight matrix interference was identified in twenty samples. The MSA was used to calculate the values for two metals in six samples.
193212	The sample matrix spike was outside of CLP control limits for three metals. The sample matrix was found to be out of control for one metal. A slight matrix interference was identified in thirteen samples. The MSA was used to calculate the values of two analytes in thirteen samples.

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**POLYCHLORINATED BIPHENYLS**  
**DATA QUALITY REVIEW**  
**TABLE 4-4**

SDG No.	Data Quality Evaluation Comments
450PW	No non-conformances reported.
297PS	The quantitated amounts in certain samples did not agree within 25%.
249PW	The surrogate decachlorobiphenyl (DCB) had a recovery below the advisory control limits.
298PS	Dilutions were required for two samples due to the presence of high levels of non-target analytes. Because of the high dilution levels, the surrogates could not be accurately identified or calculated. The relative percent difference (RPD) value for Arochlor 1254 did not meet criteria.
299PS	The recovery for DCB could not be accurately quantitated due to severe matrix interference in one sample. The recovery for tetrachloro-m-xylene (TCX) could not be accurately identified or quantitated on the analytical column due to severe matrix interferences in one sample.
251P	The surrogate DCB fell below the acceptance limit in two samples. Not enough raw sample was available for re-extraction and reanalyses of the samples.
252PW	No non-conformances reported.
300PS	The quantitated target analytes between the two columns did not agree to within 25%. The surrogate TCX failed recovery criteria in the confirmation analyses of three samples. The surrogate DCB had a recovery that exceeded the acceptance limit in the analysis of one sample. The recoveries of TCX and DCB failed recovery criteria in the confirmation analysis of one sample. The failing recoveries discussed above have been attributed to the interferences by non-target analytes present in the particular sample matrices.
235PW	No non-conformances reported.
301PS	One sample result was not within 25% agreement between the analytical columns.
254PW	The surrogate DCB failed advisory criteria in one sample and in the primary and confirmation analyses of another sample due to severe matrix interference. Sufficient sample was not available for additional analysis.
302PS	The recoveries of DCB in one sample exceeded the upper acceptance limit.
305PS	Second column analyses were required to confirm the presence of one or more target analytes in two samples.
303PS	The surrogate DCB could not be accurately quantitated in two samples due to matrix interference.

South Carolina Aquarium Site  
Charleston, South Carolina  
**POLYCHLORINATED BIPHENYLS**  
**DATA QUALITY REVIEW**  
**TABLE 4-4 (continued)**

SDG No.	Data Quality Evaluation Comments
255PW	No non-conformances reported.
306PS	No non-conformances reported.
257PW	No non-conformances reported.
307PS	The recoveries of TCX failed criteria in the confirmation analyses of 11 samples. The recovery of DCB also failed criteria on the confirmation and/or primary analyses of three samples. Due to severe matrix interference and high dilution factors, no surrogate recoveries were obtained for six samples.
312PS	No surrogate recoveries were obtained in six samples due to high dilution. The recoveries of BFB and/or TCX failed recovery criteria in the primary and/or confirmation analyses in two samples. The duplicate matrix spikes did not meet recovery or relative percent difference criteria because of the high dilution level required.
310PS	Two samples were re-extracted outside of holding times since all QC criteria had not been met. Second column analyses were required to confirm the presence of one or more target analytes in ten samples. One to two TCL analytes were confirmed at concentrations above the CRQL. Due to high levels of dilution and matrix interference, no surrogates were recovered in eight samples. The recovery for TCX failed criteria in the primary analysis of one sample. The surrogate DCB failed criteria in the analysis of another sample.
311PS	The recoveries of TCX and/or DCB failed recovery criteria in the primary and/or confirmation analyses of twelve samples due to dilutions and sample matrices. The surrogates for the MSD did not meet all recovery criteria.
258PW	No non-conformances reported.

South Carolina Aquarium Site  
Charleston, South Carolina  
**TAL/TCL INORGANICS**  
**DATA QUALITY REVIEW**  
**TABLE 4-5A**

SDG No.	Data Quality Evaluation Comments
832319	The sample matrix spike was outside the CLP control limits for five metals. The sample matrix duplicate was out of control for four metals. A slight matrix related interference is present in sixteen samples as determined by analytical spike recovery that is wide of the 85% to 115% CLP acceptability limits in samples which exhibit a relatively low concentration of the analyte.
823363	No non-conformances reported.
323619	A slight matrix related interference was present in four samples.
323510	The sample matrix spike was found to be outside CLP control limits for four metals. The sample matrix duplicate was out of control for five metals. A slight matrix related interference was present in eighteen samples. The Method of Standard Additions (MSA) was used to calculate the value of three metals.
323331	The sample matrix spike was found to be outside CLP control limits for four metals. The sample matrix duplicate was out of control for one metal. A slight matrix related interference is present in nineteen samples. The MSA was used to calculate the values of two metals.
323717	The sample matrix spike was found to be outside CLP control limits for two metals. The sample matrix duplicate was out of control for seven metals. A slight matrix related interference is present for six samples. The MSA was used to calculate the values of two metals.
323733	The sample matrix spike was found to be out of CLP control limits for seven metals. The sample matrix duplicate was out of control for five metals. The MSA was used to calculate the values of arsenic.
231052	The sample matrix spike was found to be out of CLP control limits for eight metals. The sample matrix duplicate was out of control for three metals. A slight matrix interference is present in seventeen samples. The MSA was used to calculate the results for one metal.
323980	A slight matrix interference was found in three samples.
231389	The sample matrix spike was found to be out of CLP control limits for six metals. The sample matrix duplicate was out of control for six metals. A slight matrix interference was identified in eighteen samples. The MSA was used to calculate the values of three metals.
231406	The sample matrix spike was found to be outside CLP control limits for five metals. The sample matrix duplicate was out of control for five metals. A slight matrix interference was identified in three samples. The Method of Standard Additions was used to calculate the values for two metals.

South Carolina Aquarium Site  
Charleston, South Carolina  
**TAL/TCL ORGANICS**  
**DATA QUALITY REVIEW**  
**TABLE 4-5B**

SDG No.	Analyses	Data Quality Evaluation Comments
00018	VOA	Common laboratory artifacts methylene chloride and acetone were identified above CRQL in many samples and in the associated method blanks. 2-Butanone or methyl ethyl ketone (MEK) were also detected in the associated method blanks.
00018	Semi-VOA	Some samples had indistinguishable coeluting isomers. These samples are flagged with an "X". A number of samples were analyzed at higher dilutions to avoid saturation of the detectors. Hand-corrections of the TCL analyte areas occurred in one or more associated samples due to the initial use of the wrong window to quantitate the TCL analyte. Certain associated Medium Level duplicate matrix spikes did not meet all advisory criteria. However, a blank spike was prepared and analyzed along with the duplicate matrix spikes and it met all advisory criteria.
00018	Pest/PCB	One or more advisory surrogates failed quality control criteria for fifteen samples. These recoveries were greater than twenty percent indicating possible extraction problems. Severe matrix interference precluded the accurate identification and quantitation of the advisory surrogates DCB and TCX for two samples. Method blanks contained acceptable levels of heptachlor, methoxychlor and Arochlor 1254.
001-B	VOA	No non-conformances reported.
001-B	Semi-VOA	No non-conformances reported.
001-B	Pest/PCB	In the analyses of three samples, one or more of the advisory surrogates fell below the quality control criteria limit on one or both columns.
208-B	VOA	No non-conformances reported.
208-B	Semi-VOA	No non-conformances reported.
208-B	Pest/PCB	The recoveries of the advisory surrogate DCB failed quality control in the initial extracts of two samples. These samples were re-extracted outside of holding times and the recovery of DCB failed again.
000489	VOA	A few TCL analytes were identified above the CRQL in three samples. Hand corrections were employed since the incorrect window had been used to quantitate the a TCL analytes initially.
00489	Semi-VOA	Samples were reanalyzed at higher dilutions due to saturation of the detectors. Hand corrections were employed since the incorrect window had been used to quantitate the a TCL analytes initially. One base surrogate failed quality control criteria in four samples. The associated duplicate matrix spikes did not meet all advisory accuracy and precision criteria.
00489	Pest/PCB	Three samples were re-analyzed at higher dilutions due to saturation of the detectors. Severe matrix interference in the analyses of five samples precluded the accurate identification and quantitation of the advisory surrogates DCB and TCX. One or more advisory surrogates in three samples and the MS and MSD, failed quality control criteria. The recoveries of spike compounds gamma-BHC and endrin were flagged as outliers in the matrix spike duplicate.

South Carolina Aquarium Site  
Charleston, South Carolina  
**TAL/TCL ORGANICS**  
**DATA QUALITY REVIEW**  
**TABLE 4-5B (continued)**

SDG No.	Analyses	Data Quality Evaluation Comments
00316	VOA	Methylene chloride and acetone were identified at concentrations above the CRQL in most of the samples. These contaminants were also found in the associated method blanks. Hand corrections were employed since the incorrect window had been used to quantitate the a TCL analyte initially.
00316	Semi-VOA	Several samples were reanalyzed due to saturation of the detectors by target analytes. One base surrogate failed quality control criteria in two samples.
00316	Pest/PCB	Several samples were reanalyzed at higher dilutions. Therefore, surrogate recoveries were diluted below detectable limits. Several matrix interferences precluded the accurate identification and quantitation of the advisory surrogate TCX in two samples.
628-B	VOA	No non-conformances reported.
628-B	Semi-VOA	No non-conformances reported.
628-B	Pest/PCB	Samples were re-extracted outside of holding time due to initial surrogate recoveries were below Compuchem's mandatory re-extraction limit. One or more of the advisory surrogates in each of the samples failed quality control criteria.
00691	VOA	Methylene chloride, acetone and 2-butanone were detected above CRQL in these samples.
00691	Semi-VOA	One sample was reanalyzed at a higher dilution due to the viscosity of the sample extract. One acid surrogate failed quality control criteria in one sample. The recoveries of four spiking compounds were flagged as outliers in the matrix spike duplicate.
950-B	VOA	No non-conformances reported.
950-B	Semi-VOA	One sample did not meet required holding times.
00703	VOA	One sample was reanalyzed at a Medium Level due to results of a screen of that sample. The method blank contained acceptable concentrations of methylene chloride and acetone. Due to the large amount of organic matter present in the Medium Level extraction, the instrument was inoperable for several hours. Therefore, the duplicate matrix spikes prepared were not analyzed.
00703	Semi-VOA	The recovery of one surrogate was flagged as an outlier in two samples and the matrix spike duplicate. The recovery of certain spike compounds were flagged as outliers in the matrix spike and the matrix spike duplicate.
00703	Pest/PCB	One sample was diluted and the surrogate recoveries were diluted out. A blank spike was prepared and analyzed along with duplicate matrix spike and it met all advisory accuracy criteria.
01032	VOA	No non-conformances reported.

South Carolina Aquarium Site  
Charleston, South Carolina  
**TAL/TCL ORGANICS**  
**DATA QUALITY REVIEW**  
**TABLE 4-5B (continued)**

SDG No.	Analyses	Data Quality Evaluation Comments
01032	Semi-VOA	More than half of the samples were reanalyzed at higher dilutions due to the presence of large quantities of organic materia in the sample extraction; the saturation of the detectors; and, to provide discernible and reproducible results.. With five exceptions, the Low Level Solid duplicate matrix spikes met all advisory criteria.
01032	Pest/PCB	Arochlor 1260 found in one sample could not be confirmed. Due to the large amount of organic material present in these samples, several samples were reanalyzed at higher dilutions. One or more advisory surrogates in thirteen of the samples failed quality control criteria.
00954	VOA (only)	No non-conformances reported.
01408	VOA	No non-conformances reported.
01408	Semi-VOA	One base surrogate failed quality control criteria in two samples. One of the method blanks contained bis(2-ethylhexyl)phthalate.
01408	Pest/PCB	Advisory surrogate DCB in four samples and an associated method blank, failed quality control criteria.
01369	VOA	One sample missed the 10 day CLP holding time. Two samples were reanalyzed using a smaller aliquot of raw sample to bring the on-column amount into range for target analytes. One sample was reanalyzed at a higher dilution due to exceedence of the instrument's analytical range.
01369	Semi-VOA	Two sample failed to meet surrogate recovery criteria. These samples were re-extracted outside of holding times. The viscosity of the extracts from four samples precluded reanalysis at a great concentration. Several samples should have been reanalyzed at Medium Level analysis. However, this determination was made after the holding times had expired. Excluding five samples, all of the surrogates met recovery criteria with two exceptions. The duplicate matrix spikes were analyzed at the same dilution levels as the samples. Therefore, many of the spiking compounds were diluted below detectable limits and their recoveries could not be calculated. A blank spike was not analyzed along with these samples because it was lost by the laboratory.
01369	Pest/PCB	Severe matrix interference on the column analyses in ten samples precluded the accurate identification and quantitation of the advisory surrogate DCB. Severe matrix interference in the column analyses of six samples precluded the accurate identification and quantitation of the advisory surrogate TCX. One or more advisory surrogates in four samples failed quality control criteria.
01386	VOA	One sample had to be re-analyzed since targeted compounds exceeded the instrument's analytical range.

South Carolina Aquarium Site  
Charleston, South Carolina  
TAL/TCL ORGANICS  
DATA QUALITY REVIEW  
TABLE 4-5B (continued)

SDG No.	Analyses	Data Quality Evaluation Comments
01386	Semi-VOA	Some samples were re-analyzed since target compounds were initially detected at levels which exceeded the instrument's analytical range. In some diluted samples, surrogate recoveries were present at concentration levels which precluded accurate quantitation. The duplicate matrix spikes did not meet all advisory accuracy and precision criteria. A quality control blank spike was extracted along with the duplicate matrix spikes; however, the extract was lost by the laboratory.
01386	Pest/PCB	Advisory surrogate TCX failed quality control criteria in two samples, the MS and the MSD. DCB failed quality control limits on one sample. Severe matrix interference precluded the accurate identification and quantitation of certain spiking compounds in the MS. A blank spike was prepared and analyzed along with the duplicate matrix spikes. It met all advisory accuracy criteria.

DIOXIN

DATA QUALITY REVIEW

TABLE 4-6

TL No.	Data Quality Evaluation Comments
94-04	No non-conformances reported.
94-02	No non-conformances reported.
94-03	The relative percent difference (RPD) between the recoveries for the target analytes spiked into the blank sample are below the QC advisory limit. One sample was re-cleaned due to a low level cross-contamination with a matrix spike sample.
94-06	No non-conformances reported.
94-05	The relative percent difference (RPD) between the recoveries for the target analytes spiked into the blank sample are below the QC advisory limit.
94-09	The samples were re-extracted due to failing to extract the matrix spike duplicate initially.
94-10	The percent recovery of one target analyte spiked into the blank was slightly above the QC advisory limits. The RPD between these recoveries were below the QC advisory limit.
94-11	The RPD between the recoveries for the target analytes spiked into the blank sample are below the QC advisory limit.
94-12	The RPD between the recoveries for the target analytes spiked into the blank sample are below the QC advisory limit.
94-14	The percent recovery of some target analytes spiked into the blank were either above or below the QC advisory limits. The RPD between these recoveries were below the QC advisory limit.
94-08	The Triangle Laboratory water blank did not meet blank contamination criteria.
94-07	The percent recovery of one target analyte spiked into the blank was below the QC advisory limits. The RPD between the recoveries was below the QC advisory limit.
94-13	The internal and surrogate standard recoveries for three samples were above the QC advisory limits.
94-15	The percent recovery of some target analytes spiked into the blank were either above or below the QC advisory limits. The RPD between the majority of the recoveries was below the QC advisory limit.
94-16	The RPD between the recoveries for the target analytes spiked into the blank sample are below the QC advisory limit.
94-17	The Triangle Laboratory soil blank was reanalyzed due to the presence of 2,3,7,8-TCDF above the target detection limit. The method blank was analyzed for confirmation and 2,3,7,8-TCDF was detected below the target detection limit. The OCDD analyte is outside of QC limits on the MS recovery. The RPD for this analyte is high (outside of QC limits).
94-18	No non-conformances reported.

## DIOXIN

## DATA QUALITY REVIEW

TABLE 4-6 (continued)

TL No.	Data Quality Evaluation Comments
94-20	The RPD between the recoveries for the target analytes spiked into the blank sample are below the QC advisory limit.
94-22	The internal and surrogate standard recoveries for two analytes were above the QC advisory limits in the method blank. The RPD between the recoveries for the target analytes spiked into the blank sample are below the QC advisory limit.
94-23	The internal standard recoveries for two analytes and the surrogate standard were outside the QC advisory limits in the method blank.
94-19	No non-conformances reported.
94-21	The internal standard recoveries for two analytes and the surrogate standard were outside the QC advisory limits in the method blank. The internal and surrogate standard recoveries for two analytes in the samples were outside of the QC advisory limits.
94-24	The RPD between the recoveries for the target analytes spiked into the blank sample are below the QC advisory limit.

South Carolina Aquarium Site  
Charleston, South Carolina  
**GROUNDWATER AND SURFACE WATER  
DATA QUALITY REVIEW**  
**TABLE 4-7**

SDG No.	Analyses	Data Quality Evaluation Comments
323968	Inorganics	The sample matrix spike was outside CLP control limits for nine metals. A slight matrix related interference for one or more analytes is present in seven samples.
958	VOA	No non-conformances reported.
958	Semi-VOA	No non-conformances reported.
958	Pest/PCB	One or more advisory surrogates failed quality control criteria in four samples.

## 5.0 HYDROGEOLOGICAL ASSESSMENT

The purpose of the hydrogeological assessment was to determine whether a significant change in contaminant distribution or contaminant flow pathways is likely to be effected by the construction activities on the proposed aquarium, or by conditions consequent to the construction, and to provide information useful for the design of a containment system, to the extent that one is deemed necessary.

Concerns have been expressed that construction activities, including the preaugering of piles, dewatering, and excavation, may cause the spread of contamination via the aquifer system or through the aquitard that underlies the surficial aquifer. If construction activities resulted in the opening of a pathway or resulted in a change of the hydraulic gradient, dissolved contamination or hydrocarbon product could potentially migrate into areas which were previously uncontaminated.

Three possible contamination release mechanisms were investigated. These are based on the location of the contamination. First, site construction activities could create a pathway from the uppermost aquifer to a lower aquifer. This could occur during or subsequent to excavating for the foundation or when preaugering or driving piles. This pathway would be a concern only if the lower aquifer were less contaminated and the hydraulic gradient along the pathway is downward or if undissolved product with density greater than that of water (DNAPL) is present. The second possible release mechanism was the converse of the first. That is, the deeper aquifer would be more contaminated than the shallow and the hydraulic gradient would be upward. Creating a vertical conduit under the hypothetical circumstances would allow dissolved contamination with higher concentrations to migrate up from below. The third release mechanism is analogous to the second, but would occur all within the uppermost aquifer. Since the upgradient portions of the uppermost aquifer were known to be more contaminated than downgradient, certain aspects of construction could shorten the groundwater travel time between these more contaminated areas and the river, potentially increasing the mass contaminant loading.

### 5.1 Regional Vertical Hydraulic Gradients

Under certain circumstances, if the drawdown in a deeper aquifer is widespread, large diversions can be induced from shallower aquifers through leakage, despite low permeability aquitards, effecting significant drawdowns in the unpumped aquifers. Theoretically these conditions can be propagated vertically by the same mechanism, causing a cascading effect. It is known that the Middendorf Aquifer is pumped by the city of Mount Pleasant two miles away. Since it is theoretically possible that a vertically downward component to the hydraulic gradient on the site could be induced at depth, an estimate of the average vertical gradient between the surface and the Middendorf Aquifer was computed.

The regional vertical hydraulic gradient was determined from data obtained by the USGS from the former production well located at the SCE&G facility and tide data for the Cooper River

from the National Oceanic and Atmospheric Administration (NOAA) Tide Tables for East Coast North and South America, 1987. The well was completed in the Middendorf Formation and is reportedly screened between the depths of 1,865 and 2,000 ft. below ground surface. Water level data have been collected in the well since April 1990 by the USGS and the average depth to water on May 3, 1994 was 56.94 ft. below ground surface which corresponds to a ground water elevation of 47.44 ft. below mean sea level (MSL). The average river level during respective parts of the monthly cycle in April, taken from the NOAA Customhouse Wharf station, was approximately 0.2 feet below MSL. An estimate of the regional vertical hydraulic gradient was calculated to be 0.024 ft/ft. in the downward direction.

## 5.2 Site Hydraulic Gradients

Water elevation data obtained from the monitoring wells on April 11, 1994 were examined in order to determine the direction and magnitude of the hydraulic gradients on site. All the wells examined are screened in the Terrace Deposits above the Cooper Formation. The water level information collected from three shallow-deep well couplets was used to calculate the vertical hydraulic gradient ( $v_v$ ). The results indicate a downward vertical gradient ranging in magnitude from 0.017 ft/ft to 0.048 ft/ft. These results are consistent with the regional vertical hydraulic gradient calculated from the SCE&G former production well, 0.024 ft/ft. Results from individual couplets are presented in Table 5-1.

A graph was plotted using the averages of ground water elevations taken from each well (through half a semi-diurnal tidal cycle on April 11, 1994) versus the wells' mid-screen elevation to quantify the influence of the screened interval depth on the ground water elevation. These data are summarized in Table 5-2 and plotted in Figure 5-1. Although the general trend demonstrates a steady decrease in potentiometric head with depth (the slope corresponds to a downward gradient of 0.019 ft/ft), the scatter in the plot ( $R$  squared equals 0.106) indicates that horizontal position is a significant factor in determining absolute potentiometric head.

Distance from the Cooper River was considered as a factor. The ground water elevations of the five wells with a mid-screen elevation at approximately sea level were plotted against the distance to the salt water intrusion line of the Cooper River (see Figure 5-2) to determine if wells closer to the river had lower ground water elevations than those at greater distances. However, of these few wells, the relation of ground water elevations to distance appears to be random. Variability of surface permeability and vegetative cover can cause non-uniform infiltration and evapotranspiration rates. In addition, the undulating site topography could cause localized recharge areas associated with surface depressions. Thus, shallow wells located in these areas could have appreciably higher elevations than wells located elsewhere. In addition, buildings in the immediate vicinity of the site which have basements may be pumping the water table aquifer in order to prevent basement flooding.

Horizontal hydraulic gradients were considered for shallow and deep zones. Several rounds of synoptic water level measurements were obtained on April 11, 1994 in order to determine the impact of tidal fluctuations on the water levels in the wells and consequently on the hydraulic

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gradients. The measurements were plotted along with two supplemental readings taken on May 4 and 5, 1994. The tidal fluctuations in the wells measured throughout a semi-diurnal cycle (from shortly before high tide to shortly after the subsequent low tide) ranged from 0.02 to 0.44 feet. The deepest wells, USGS-1, USGS-2, and MW-KA1, taken as a class, exhibited the greatest fluctuations, ranging from 0.15 to 0.44 feet. Wells adjacent to the drainage structure, MW-3, MW-5, and MW-9, showed the second greatest fluctuation, ranging from 0.10 to 0.22 feet. The drainage structure is exposed at low tide and submerged at high tide. MW-8 and MW-11, wells of intermediate depth, exhibited 0.10 and 0.09 feet of fluctuation, respectively, greater than the fluctuations of any of the seven remaining shallower wells. Since the Town Creek channel is dredged to the approximate depth of the deepest wells, the strata that these wells penetrate are exposed. Consequently, a direct horizontal hydraulic connection is open between the deepest wells and Town Creek.

The Calhoun Park Area Preliminary Site Characterization Summary, prepared by Chester Environmental, indicates a hydraulic mound centered in the vicinity of MW-6 and MW-7, with water levels dropping off sharply in the direction of the drainage structure to the south and the Cooper River to the east. The horizontal gradient to the north is presented as slightly less steep and that to the west is very gentle, owing to the increasing proximity to a larger mound on the SCE&G property. Shallow wells in the CHS site adjacent to the condominium complex south of the drainage structure also exhibit high water levels. The average of the ground water measurements taken by Killam on April 11, 1994 generally agree with this assessment, except that the water levels in two of the wells near the drainage structure, MW-5 and MW-9, do not appear to be significantly lower than in other shallow wells on the site, and the steep gradient toward the river cannot be duplicated because water levels in MW-8 and MW-11 are not sufficiently lower than those in MW-6 and MW-7. It was conceivable that Killam's average water levels may not have been collected on a representative day. On May 5, 1994, at approximately the time of low tide, Killam collected a synoptic round of water levels. In this round, presented in Table 5-3, the highest point in the hydraulic mound exists in the vicinity of MW-11 near the center of the aquarium parcel, and the level in MW-8 is essentially identical to that in MW-7. The water level at MW-6 is lower. In addition, wells MW-1, MW-2, MW-6, and MW-12 all exhibited heads lower than one or more of the three wells adjacent to the drainage structure. MW-2 has a water level lower than any of the wells along the drain; its water level was the lowest measured in that round. Considering that MW-9, the nearest to the river and also adjacent to the drainage structure, had a water level only 0.01 feet lower than MW-6, it would be difficult to demonstrate any flow toward the river.

According to the NOAA tide tables for Charleston, South Carolina, average water level elevation in the Cooper River should be 2.6 feet above the local datum which is at -2.8 feet MSL in this area. Accordingly, we would expect the average tide height to be 0.2 feet below MSL. There should ultimately be a net gradient, and consequently a net flow, toward the river. Therefore, the potentiometric head in the area between the locations of wells MW-8 and MW-11 and the river is expected to be directed toward the river. Depending on the relative resistance to flow of the aquifer and the riverbed material, the hydraulic gradient could be more or less gentle toward the river. A conservative estimate of the gradient can be made with the following

assumptions: (1) the riverbed material offers no resistance to flow, so that the head in the aquifer can match the tide elevation at the strand line; and (2) the mean high water line is used as the strand line. MW-11 is approximately 135 feet from the mean high water line. Using the high tide ground water elevation for January 8, 1994 for MW-11, presented in the Calhoun Park Area Preliminary Site Characterization Summary as 3.72 feet MSL, a conservatively high estimate of the average horizontal hydraulic gradient was calculated at 0.029 ft/ft. If the riverbed materials are significantly less permeable than the fill aquifer, a much lower gradient would result.

Contour maps presented in the Preliminary Site Characterization Summary indicate a general trend in the deeper wells toward the southeast. The very strong response of well USGS-1 to tidal fluctuations results in the reversal of the gradient in the high tide map. Killam measurements of MW-KA1, USGS-1, USGS-2, and USGS-3 generally concur, except the average water level in USGS-1 is somewhat higher than would be expected. These observations are also true of the low tide data collected on May 5, 1994. The horizontal component to the hydraulic gradient in the 42 to 50 ft. depth zone is 0.01 ft/ft.

### 5.3 Contaminant Migration

The materials and stratigraphy encountered in Killam's boring plan concur with the general description of the shallow stratigraphy presented in the Preliminary Site Characterization Summary report. The materials encountered were rather well stratified, including typically (in descending order) 10 to 20 feet of heterogeneous fill, 20 to 30 feet of gray green to black silt and silty clay, 10 to 20 feet of greenish gray fine sands or silty and clayey sands, and 25 or more feet of greenish gray clays, silty clays, and sandy clays. Eastward of the salt water critical line, the upper silt and silty clay layer thickens and the fill consequently thins. The sand unit, which is centered at approximately 40 feet of depth, is the major conductive unit of consequence below the fill. Given the horizontal and vertical gradients discussed in the preceding section, the flow in the fill and the fine sand unit will be essentially horizontal, with flow in the intervening silt and clay layer being essentially vertically downward. Given the strong depression in the Middendorf Aquifer measured in the inactive SCE&G well noted earlier, it is conceivable that the aquifers locally experience a cascading effect, as described earlier. This might explain the vertical gradient. If this is the case, contamination released in the fill could move downward into underlying units in areas where the horizontal gradient is virtually nil and an appropriately located conduit is available. In the present case, however, this is unlikely, because the sand unit below the upper silt and clay unit has a strong horizontal gradient and would carry the contamination southeastward to the Cooper River. This point suggests the other possible cause of the strong downward gradient measured in the well couplets: the dredging of the Town Creek channel. Since the channel is cut to the depth of the strata intersected by the deeper wells and the tidal effects are strongest in these wells, it is likely that the exposed stratum equilibrates more easily with the river than the fill does, due to the presence of tarred sands and the thickening of the upper silt and clay layer observed where the fill stratum intersects the riverbed. These features of the intersection may explain why the water levels in wells MW-8 and MW-11 are as high as they were observed to be.

As noted in Section 3.0, while the contamination is significant in the soils, the ground water is relatively much cleaner. This is due to the fact that the majority of the contamination has a rather low solubility. The contamination in the deep well, MW-KA1, was much less than in the two shallow wells sampled, MW-8 and MW-11. This may be a result of a downward migration of contaminants from the more contaminated fill to the sand aquifer, or (given the presence of hydrocarbon impacted soils at depth) it may be a function of the greater dilution and flushing of the lower sand unit which has been described here.

#### **5.4 Contaminant Migration Scenarios**

Of the alternative construction-related contamination migration scenarios described previously, the migration of contamination from the lower sand unit to the water table aquifer is not likely to be an issue. The hydraulic gradient has a strong downward component and the bulk of the contamination is shallow. The hydrogeological conditions observed at the site indicate that the downward migration of contamination (to the sand aquifer and ultimately to the Cooper River) and an increase in the rate of discharge of the water table aquifer to the river are the two scenarios which require further consideration.

Since excavating is not likely to breach the upper silt and silty clay layer, the only mechanisms by which a pathway could be opened between the fill aquifer and the lower sand unit would be the driving and preaugering of piles, especially the latter, as it could leave an 18-inch diameter conduit open for a short period of time. It has been estimated that such a conduit would be open for no more than 30 minutes. While it is possible that a pocket of hydrocarbon product could be mobilized and seep down or be smeared down an open hole to a lower level, hydrocarbon product is already known at depth and the small contribution from the area of the side of any pocket of contamination is not likely to significantly increase the dissolved contaminant loading in the Cooper River. The greater concern is for the migration of dissolved contamination from the fill aquifer to the sand layer. The concentration of dissolved total PAH in well MW-11 was found to be over 500  $\mu\text{g/L}$ . While this is somewhat higher than the Lowest Observed Effect Level (LOEL), it is roughly two orders of magnitude greater than the concentration measured in MW-KA1.

The amount of groundwater that can pass through a pre-augered hole depends on the length of time the hole is open, the diameter of the hole and whether it collapses or not, the surface roughness of the hole, and the pressure difference between its two ends. Since the preaugered holes will transect a variety of soil types, it is likely that the augered holes will collapse in a number of cases, due to fluid sands entering the borehole. When the borehole is collapsed, it will present an effective barrier to the migration of dissolved contamination. However, it is also likely that the borehole will remain open in other cases.

If we conservatively assume that the hole will not collapse, we can apply pipe flow equations to calculate the flow rate that would be induced by the pressure difference between the water table aquifer and the lower sand unit. However, since the ends of the borehole will effectively open into aquifer units, the transfer of water will result in a loss of pressure in the fill aquifer

even as a hydraulic mound is induced in the sand aquifer. As the pressure in the two units approach each other in the vicinity of the borehole, the flow will slow significantly. If the two units approach equilibration in a short period of time, the total diversion from the fill aquifer may be much less than would be expected assuming the pressure difference is held constant. The rate at which equilibration is approached and specific flow rates at individual points in time will be strongly dependent on the transmissivities of the two aquifer units. If one or the other of the units is very resistant to flow, with respect to the conduit, equilibration will be approached slowly, but the overall rate of flow will be smaller. If both units have higher transmissivity, equilibration will be approached more quickly, but the overall rate of flow will be much greater.

Assuming that the pre-augered holes will remain open for up to 30 minutes before the piles are driven in place, and that an initial vertical gradient of 0.1 ft/ft (twice the maximum measured on the site) will exist at the time the piles are driven, a finite-difference simulation was performed on a personal computer using the U.S. Geological Survey MODFLOW package. A 35-column by 31-row finite difference grid was created, with cell dimensions expanding at the rate of approximately 50 percent from a centrally located cell, which was assigned dimensions to reflect the cross-sectional area of an open 18-inch borehole.

The model has two layers, representing the fill and the sand aquifers. The fill layer is truncated (cells beyond column 29 are inactive) at the approximate horizontal position of the deepest part of the oiled littoral zone. The sand layer is bounded on one side by a column of constant head cells corresponding to the position of the Town Creek Channel. The hydraulic conductivity of the fill is estimated at 0.01 ft/min. This represents an estimate in the range of fine to medium sand. A saturated thickness of 7.5 feet was used based on the water levels measured at the site and the depth of the bottom of the fill. A specific yield of 0.15 was used for the fill aquifer. This value could vary from 1 to 30 percent, but the parameter is not as critical as transmissivity. The value chosen is expected to be realistic. The hydraulic conductivity of the sand aquifer is most critical: the value chosen (0.01 ft/min), is conservatively high for the fine sands to silty or clayey sands described in the on-site borings. The actual value is likely to be closer to 0.001 ft/min and could be lower. A thickness of 15 feet was chosen as a likely average based on the range of thicknesses encountered in the on-site borings. A storativity of 0.0001 was chosen for the sand layer. This value is about the middle of the range for confined silty sand aquifers and other normally encountered values would not significantly alter the results of the simulations. Although there will be some leakage through the aquitard separating actual aquifers, the rate of leakage could range from less than 0.01 to over 10.0 gallons per day. It should be noted that the upper limit is extremely unlikely unless there are already vertical conduits along existing piles. An extremely low vertical conductance between the layers was chosen, for all cells except for the one representing a pre-augered hole, in order to prevent having to recharge the upper layer and calibrate to a steady state. It was reasoned that it would be conservative to consider any leakage, other than that which passes through the borehole, to be insignificant.

Finally, the vertical conductance of the cell representing the borehole was estimated. Hydraulic conductance can be expressed as the ratio of discharge through a system to the change in hydraulic head across the system:  $C = Q/h$ . For the initial head conditions, borehole diameter,

and distance between aquifers, and assuming a 1.8-inch surface roughness height, the flow in the conduit was expected to be turbulent (Reynold's Number = 1,182,000; transition from laminar to turbulent flow occurs when the Reynold's Number exceeds approximately 2,000), which would result in greater resistance to flow. Since MODFLOW takes conductance as a constant, only one value could be entered. Truly simulating high-Reynold's Number flow would require being able to allow conductance to vary with changes in hydraulic gradient. Therefore, a single value that could best represent the hydraulic gradient was needed. Preliminary simulations indicated that the head difference drops below 0.0001 feet within the first minute. This is the smallest positive value that can be represented using the MODFLOW output formatting package (FORTRAN Floating Point Format: F7.4) without redefining the length unit. However, at this point, the Reynold's Number (= 7,500) would be dropping near to 2,000 and continued reduction in the head difference could cause the flow to become laminar. Inverting the Darcy-Weisbach equation (governing turbulent flow in a pipe) and solving for discharge (Q) at various values of head drop (h) demonstrated that the conductance could reach a value of over 400,000 cfm/ft if the head difference falls to  $0.25 \times 10^{-5}$  (Reynold's Number = 1,182). This conductance is not significantly less than the value one would obtain by inverting the Hagen-Poiseuille equation (governing laminar flow in pipes): 781,000 cfm/ft. Since the conductance is a constant when the flow is laminar, only a single value is needed to simulate laminar flow. For the sake of simplifying the simulation, as well as being conservative, the laminar flow condition was assumed and the higher, Hagen-Poiseuille value chosen for the conductance.

The MODFLOW results indicate that the average flow rate will drop gradually from about 0.78 cfm during the first half-second of the hole being open to about 0.21 cfm during the period between 5 and 10 elapsed minutes. During the first 10 minutes, given the conservative assumptions imposed on the model, it is estimated that up to 17 gallons will pass from the fill aquifer to the sand layer. The rate of flow continues to decrease more slowly as time passes. At 30 minutes, the model predicts that the open borehole will pass approximately 45 gallons of water. Based on a total of 270 preaugered boreholes, it is estimated that the total flow from the fill aquifer to the sand aquifer will be less than 12,150 (46,000 liters) gallons. Assuming that the PAH concentration at MW-11 (540  $\mu\text{g/l}$ ) is representative of the area to be pre-augered, the total mass of PAH contaminant introduced by the estimated transfer of groundwater to the sand layer would be approximately 25 grams. Given the presence of PAH at depth at the site and the overall level of contaminants in the upland soils, we believe that the transfer of this mass of PAH from the fill to the sand aquifer is insignificant.

Any dissolved contamination which does penetrate to the underlying sand would be carried ultimately to the Cooper River and be subject to considerable dispersive dilution along the way. The construction specifications should indicate that priority be given to minimizing the time elapsed between the end of the drilling of a borehole and the driving of the pile. Monitoring the water quality in the sand aquifer downgradient of the aquarium site is recommended. Due to the connection between the sand layer and the Town Creek Channel, it is highly unlikely that any deeper aquifers will be impacted.

The third mechanism for contaminant spreading (discharge of the fill aquifer to the river) was also evaluated. The construction activities could alter some of the features of the site hydrology. First, excavation could potentially mobilize hydrocarbon product that is currently bound up by localized low permeability layers. Second, since the fill aquifer is probably laterally confined by its reduced cross sectional area riverward of the strand line and by the tarred sands which make up the littoral zone, proposed intertidal excavations (to remove debris prior to preaugering) may remove obstructions to the groundwater flow and marginally enhance the discharge of the fill aquifer to the river. As the levels of contaminants are low, the need for containment is marginal. Nonetheless, the implementation of containment mechanisms to avoid increased discharges from the fill aquifer to the river are advisable.

Dewatering portions of the site during construction are likely to alter existing groundwater flow patterns, and in so doing, may mobilize contaminants from one area of the site to another. Dewatering without peripheral sheeting is likely to induce much more water from the fill than would otherwise be induced through the silt and silty clay layer with sheeting in place. In addition, the water will require proper disposal. Sheeting is recommended to reduce the amount of water pumped from the site during dewatering operations.

### 5.5 Summary

To sum up the hydrogeological assessment, the potential for contaminant migration to occur through the open preaugered borehole appears to be minimal based on the predicted flow through such an open channel. A change in the preaugering plan does not appear to be warranted based on this analysis, although the use of driven piles may offer a somewhat smaller potential for contaminant migration. Some downward smearing of product is possible under pre-augered or driven pile scenarios.

With regard to the fill aquifer, this analysis indicates that flow to the Cooper River is minimized by the presence of a reduced cross sectional area of the fill as the River is approached, as well as by tarred sands which tend to "plug" the aquifer. Construction activities (excavation) which may increase the rate of flow toward the River should be contained to avoid this effect.

South Carolina Aquarium Site  
Charleston, South Carolina

LOCAL VERTICAL HYDRAULIC GRADIENT

TABLE 5-1

Well Couplet	GW Elevation	$(h_2-h_1)$	Mid-Screen Elevation	$(l_2-l_1)$	$v_i$
MW-4 USGS-3	3.17 1.53	-1.64	4.37 -29.93	-34.30	0.048 ↓
MW-9 USGS-1	2.27 1.77	-0.50	-1.3 -31.32	-30.02	0.017 ↓
USGS-2S USGS-2	4.72 3.82	-0.90	0.23 -28.82	-29.05	0.031 ↓

Notes:

$$v_i = (h_2-h_1) \div (l_2-l_1)$$

$v_i$  in units of ft/ft

All elevations are in feet above Mean Sea Level

GW elevations measured on April 11, 1994

↓ = Downward Gradient

South Carolina Aquarium Site  
Charleston, South Carolina

AVERAGE GROUNDWATER ELEVATIONS FOR APRIL 11, 1994  
COMPARED WITH SCREEN ELEVATIONS

TABLE 5-2


WELL	TOC ELEV.	AVERAGE GW ELEV.	TOTAL DOW	SCREEN BOT. ELEV.	MID-SCREEN ELEV.
MW-1	8.87	2.42	11.6 *	-0.73	2.77
MW-2	8.92	2.09	11.7 *	-0.78	2.72
MW-3	8.43	1.61	15.9 *	-5.47	0.03
MW-4	10.77	3.17	13.4 *	-0.63	4.37
MW-5	9.71	2.41	15.2 *	-3.49	1.51
MW-6	8.93	2.70	15.0 *	-4.07	-0.07
MW-7	9.32	2.83	14.4 *	-3.08	1.92
MW-8	8.25	2.28	28.4 *	-18.15	-11.65
MW-9	8.90	2.27	19.2 *	-8.30	-1.30
MW-10	9.74	3.12	17.1 *	-5.36	0.64
MW-11	8.59	2.65	26.7 *	-16.11	-8.61
MW-12	8.71	2.40	16.4 *	-5.69	0.31
USGS-1	9.68	1.77	46.0	-36.32	-31.32
USGS-2	8.18	3.82	42.0	-33.82	-28.82
USGS-2S	8.23	4.72	13.0	-4.77	0.23
USGS-3	10.07	1.53	50.0	-34.93	-29.93
MW-KA1	7.21	1.48	49.5	-42.29	-37.29

Notes:

Average of GW Elevations collected on April 11, 1994.

TOC ELEV.: Top Of Casing Elevation (feet above MSL)

Total DOW: Total Depth Of Well

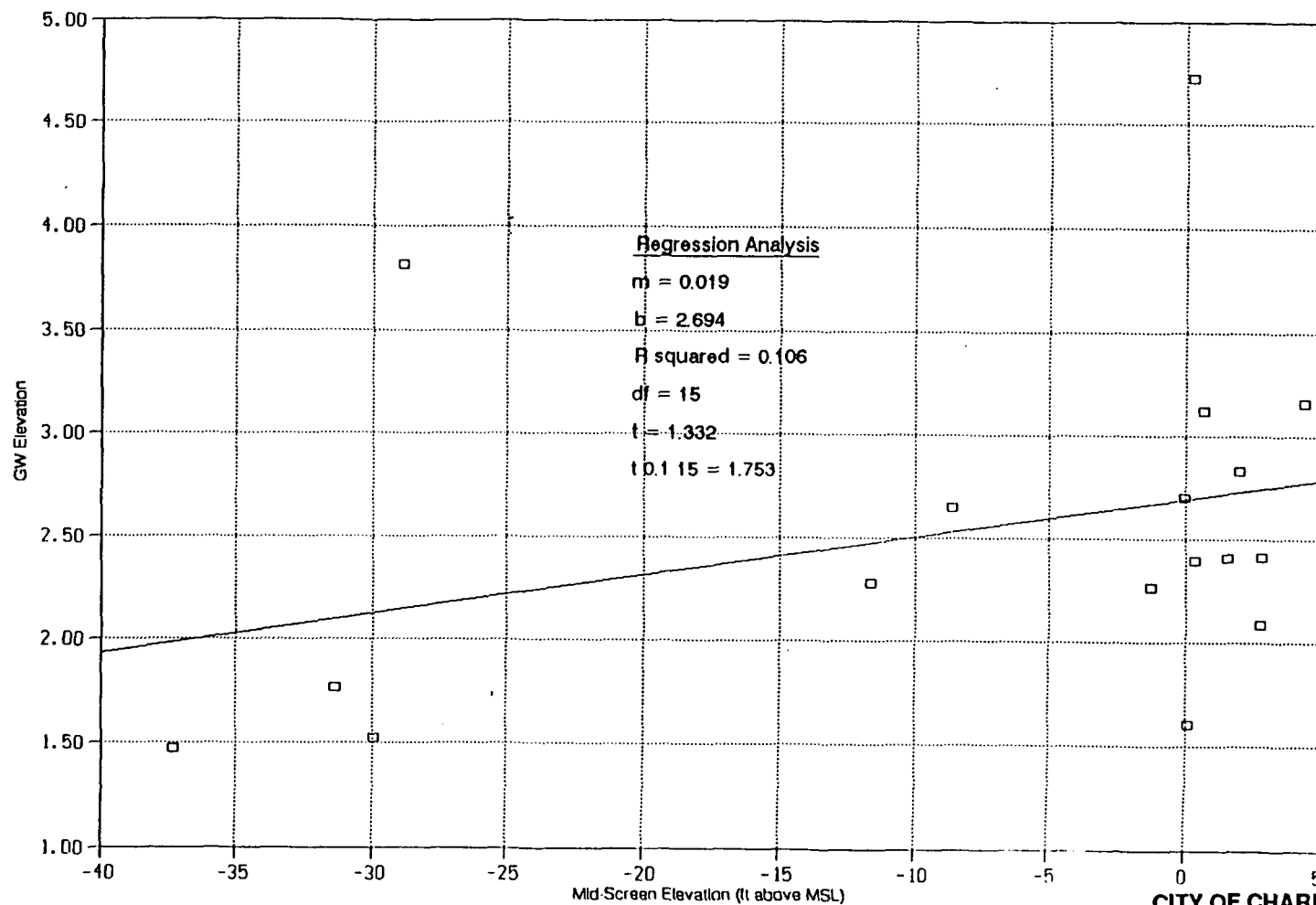
 Killam: Depth includes a 2 ft section of blank casing at bottom which acts as sediment/hydrocarbon product collector.

South Carolina Aquarium Site  
Charleston, South Carolina

SYNOPTIC LOW TIDE WATER LEVEL ELEVATIONS  
A.M. MAY 5, 1994

TABLE 5-3

WELL	GW ELEV.
MW-1	2.15
MW-2	1.52
MW-3	1.75
MW-4	3.05
MW-5	2.36
MW-6	2.38
MW-7	2.55
MW-8	2.53
MW-9	2.32
MW-10	2.92
MW-11	2.71
MW-12	2.26
USGS-1	1.88
USGS-2	3.98
USGS-2S	4.17
USGS-3	1.70
MW-KA1	1.59



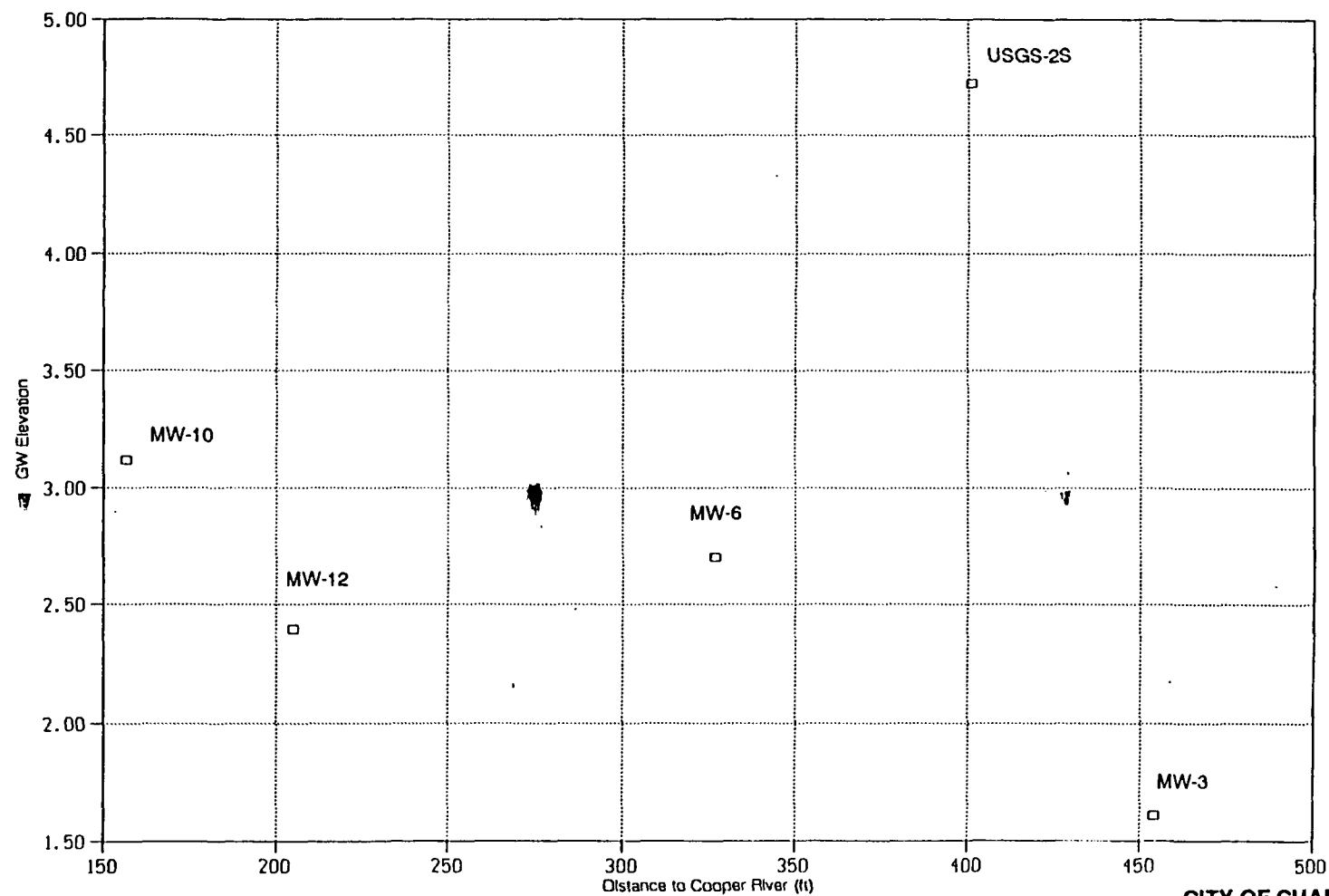
CITY OF CHARLESTON  
CHARLESTON, SOUTH CAROLINA

SITE INVESTIGATION RESULTS AND  
CONCEPTUAL CONTAINMENT PLAN  
SOUTH CAROLINA AQUARIUM SITE

Plot of Groundwater Elevations vs.  
Mid-Screen Elevations

FIGURE 5-1

**Killam**  
Associates/Consulting Engineers



**CITY OF CHARLESTON  
CHARLESTON, SOUTH CAROLINA  
SITE INVESTIGATION RESULTS AND  
CONCEPTUAL CONTAINMENT PLAN  
SOUTH CAROLINA AQUARIUM SITE**

**Plot of Groundwater Elevations vs.  
Distance To Cooper River**

**FIGURE 5-2**

## **6.0 ASSESSMENT OF CONTAMINANT MIGRATION PATHWAYS**

The purpose of this Section is to define those components of the site which require containment. Site components include the various soil horizons, groundwater, intertidal soils, and subtidal sediments. Each will be discussed separately.

### **6.1 Upland Soils - Horizons A and B**

Horizon A consists of those soils which are present above the finished basement elevation of the Aquarium, and includes those soils at the site above 3 feet MSL. Horizon B soils are those which will be excavated to allow for the construction of the pile caps. Horizon B soils will also be excavated for the purpose of removing buried debris which interferes with the augering or driving of pilings.

Horizon A and B soils will be excavated, removed from the site, and disposed of in accordance with applicable waste disposal regulations. During excavation, erosion and runoff may transport soils to the Cooper River. Soils may also be transported off-site by tracking on vehicle wheels and by fugitive dust emissions. The analytical data for Horizon A and/or Horizon B indicate that the soils contain levels of contaminants (notably PAHs, metals and observed hydrocarbon product) which require containment. Without containment, the risk of contaminant discharge from Horizon A and B soils to the Cooper River, to adjacent land areas, or to the atmosphere could be high.

Containment of Horizon A and B soils should prevent erosion of the soils to the Cooper River and onto adjacent land areas. In addition, fugitive dust emissions should be controlled. Workers will directly contact Horizon A and B soils, and should be protected by an appropriate Health and Safety Plan. A specification for a construction Health and Safety Plan will be included in the documents which collectively comprise the Containment Plan.

### **6.2 Upland Soils - Horizon C**

Horizon C soils will be exposed following the excavation and removal of Horizon A and B soils. In addition, pre-augering will bring to the surface drill cuttings which consist of Horizon C soils. These drill cuttings will be removed from the site and disposed of in accordance with applicable waste disposal regulations. The same transport mechanisms which could result in releases to the Cooper River, adjacent land, or the atmosphere from Horizon A and B soils exist with respect to Horizon C. The analytical data presented in Section 3 also indicate the need for containment of Horizon C soils based on levels of PAHs, metals, PCBs and observed hydrocarbon product. Without containment, the risk of discharge of Horizon C soils to the environment could be high.

Horizon C is different from the overlying soils in that these soils will remain in place following construction. The construction project will effectively cover or cap exposed Horizon C soils, thereby preventing direct contact between site occupants and the soils, and also preventing

erosion of soils to the adjacent environment over the long term. The newly constructed surfaces are expected to be impermeable (building cover, parking) and will be maintained in sound condition.

Containment of Horizon C soils should prevent erosion of soils to the Cooper River, and onto adjacent land areas during construction. In addition, fugitive dust emissions should be controlled. Workers in contact with these soils should be protected by an appropriate Health and Safety Plan. Finally, the project's design should provide for permanent surfaces to "cap" the remaining Horizon C soils over the long term.

### **6.3 Intertidal Soils**

The soils and/or sediments occupying the intertidal zone of the site will be subject to excavation for the purpose of removal of debris. Debris occurs extensively in the intertidal zone, as it was placed in this location for the purpose of stabilizing the river bank. The types of debris encountered in the investigation included large pieces of stone block, large pieces of metallic slag, what are thought to be steel gun turrets, and timbers. Timbers occur throughout the site as remnants of former pilings, as well as remnants of rail lines, trestles and slipways used in ship construction. Debris must be removed from certain areas of the site, as it prevents the augering or driving of piles. The excavation of this debris is expected to be intrusive and disruptive. Excavation of intertidal soils for purposes of pile cap construction will be minor, as the pile cap bottoms are located above the existing mud line.

The analytical data presented in Section 3 indicate the need for containment of the intertidal soils. This is based on the presence of PAHs, PCBs and metals, and the visual observation of some hydrocarbon product. Without containment, the risk of release to the environment from the intertidal soils could be very high. Containment of the intertidal soils should prevent their erosion to the Cooper River, and the leaching of hydrocarbon product from these soils by tidal action. Tracking of these soils to adjacent land areas should also be minimized. It is not expected that fugitive dust emissions will be a problem. Those construction workers who directly contact these soils should be protected by an appropriate Health and Safety Plan.

### **6.4 Subtidal Sediments**

Subtidal sediments are those sediments within the site which lie riverward of the low tide line. Excavation will not occur in the subtidal area. Any pile caps in this area are elevated above the mud line. The major intrusive activity which will occur in the subtidal area will be pile driving. Only three pile locations which are scheduled for preaugering are located below the low tide line.

The analytical data presented in Section 3 indicate the need for containment of the subtidal sediments. This is based on the presence of hydrocarbon product, PAHs, and metals. Without containment, the risk of release to the environment from the subtidal soils could be high.

## Killam

Containment of the subtidal sediments should prevent the release of sediments to the overlying water column and to adjacent areas of the Cooper River. The movement of contaminants to adjacent upland areas is insignificant, the risk of release to the atmosphere is zero, and the potential exposure to workers is low.

### 6.5 Groundwater

Groundwater occurs beneath the site in the shallow fill aquifer, and also in a deeper sand aquifer, which begins approximately 40 feet beneath the site. The groundwater of both aquifers is much cleaner than the upland soils. In relative terms, and judging by the very limited groundwater data available, the fill aquifer contains higher concentrations of contaminants than does the deeper sand aquifer. The risk of increased releases of dissolved contaminants via groundwater (from the fill aquifer and the sand aquifer) to the environment without containment is considered to be low. Preaugering, then driving piles may result in some downward smearing of hydrocarbon product along the pilings, although hydrocarbon product is already present at depth.

The groundwater present in the fill aquifer will be pumped during construction to dewater portions of the site. Pumping of the deeper aquifer will not occur.

Containment of the deeper sand aquifer (which discharges to the Cooper River) is not necessary. Containment of the shallow fill aquifer, which has a restricted discharge to the Cooper River and to immediately adjacent land areas, is only necessary to a limited degree. However it is advisable that the construction and the presence of the Aquarium not allow the discharge of this aquifer to the Cooper River to increase significantly.

## 7.0 RESPONSES TO AGENCY COMMENTS

The following is a compilation of comments received by the National Park Service on the Site Investigation, Conceptual Containment Plan, and Environmental Monitoring and Response Plans prepared by Killam Associates on behalf of the City of Charleston's South Carolina Aquarium Project. This compilation was prepared by the National Park Service and was forwarded to the City for evaluation and response. In order to facilitate a direct response to each of the comments, the exact text of the compilation of comments is reproduced herein, with each comment followed by *responses in italics*. Responses were prepared by Killam Associates and F.R. Harris, in consultation with the City's project team.

The compilation of comments, as received by the City, immediately follows:

Comments were received from Law Environmental(LAW) under contract to the National Park Service(NPS), U.S. Environmental Protection Agency, Region IV(EPA), National Oceanic and Atmospheric Administration(NOAA), South Carolina Wildlife & Marine Resources Department(W&MRD), U.S. Fish and Wildlife Service(USFWS), South Carolina Electric and Gas Company(SCE&G), South Carolina Department of Health and Environmental Control(SCDHEC), and U.S. Geological Survey(USGS). All comments are combined by the National Park Service for the City of Charleston to respond. Individual comments from each agencies/trustees were also forwarded to the City for consideration as soon as they were received by the NPS.

### Comment 1. by LAW, DHEC, NOAA, W&MRD

General - The document makes repeated comments to differences in the data set from those potentially obtained during a Remedial Investigation. These comments are not necessary and, in some instances, misleading. The intention of the investigation was to determine the presence and distribution of contamination within the construction footprint of the aquarium. The sampling was intentionally biased in the selection of samples for analyses. We would simply point out that an RI/FS typically does the same type of sampling since the purpose of an environmental investigation is not to find the "average" contamination on a given site, but to determine if the worst spots are a threat to human health or the environment.

*The discussion in the report regarding the degree of bias which is contained in the data set was presented in order to alert the reader as to the essential differences between this data set and other data sets which have been generated by previous studies near the Aquarium site. In the present case, the data set was intended to represent worst case conditions, and the wording in the text was intended to remind readers of that objective.*

*Comparisons between the present investigation and "typical" RI/FS studies have been made in the discussion over this point. Not only was the present investigation designed to document the presence of contamination within the site, but the very worst cases of contamination were deliberately sought out and documented (via the sample selection procedure). This is consistent with the objective of determining the need for containment and designing a containment plan.*

*Killam agrees that there is not a "typical" or "standard" approach to an RI/FS. Sampling plans included in RI/FS studies have multiple objectives, with differing degrees of bias. These objectives include: documenting worst case conditions (which has treatment implications), evaluating suspect areas of the site (some of which will be clean), identifying the extent of contamination (by taking samples beyond the suspected limit of contamination, and characterizing average conditions (typically through the use of a grid). In many instances, the selection of sample intervals is determined before field work is begun.*

*In contrast, the primary criterion for sample selection in the present investigation was documentation of apparent worst case conditions. This was reinforced by the large number of samples screened in Horizon C from which contaminated samples could be selected for laboratory analysis. The net result was the high degree of bias which is contained in the dataset, particularly in Horizon C. Killam feels that the discussion in the report is appropriate in order to make clear to the reader the circumstances which resulted in this dataset. The discussion is not intended to minimize the significance of the resulting data.*

*This issue was broached by EPA in their comments on the Workplan prior to the investigation. EPA noted that if a portion of the samples were randomly selected, the value of the dataset would be enhanced since it would be possible to evaluate the randomly selected samples and obtain an understanding of "average" site conditions, rather than only "worst case." For this reason, the approach was modified to accomplish this. In Killam's review of the data, some differences between the random subset and the biased subset were identified and discussed, in the context of the degree of bias.*

*Supplemental Region IV Risk Assessment Guidance, dated March 26, 1991, states that non-detect concentrations should not be incorporated into the average concentrations, the intention being that the average concentrations represent the average for the contaminated areas, not the entire study area. The substitution of zero for non-detects may significantly lower the calculated average for total PAHs, total CaPAHs, and total PCBs (pg. 3-4) and mask the presence of "hot spots".*

*First, the subject document is not a risk assessment, but is an overall characterization of a rather small site. Averaging only positive results would have little meaning in the present case, and would be statistically or scientifically unsupportable. The substitution of zero for non-detects would have the effect of lowering the calculated average for total PAHs, etc., but these numbers are high enough to warrant containment in any event. On the other hand, for "clean" samples, the failure to substitute zero for non-detects would result in the erroneous reporting of positive*

*results in clean samples. Please note that this substitution was only done in the case of total PAH, total cPAH, and total PCBs. Also note that when the laboratory reports a parameter as "10 ppb ND" that this literally means that the analyte was not detectable at the reported concentration. However, in many cases parameters were detectable, but simply not accurately quantifiable below the laboratory detection limits. In these situations, the parameter concentration was estimated, and flagged with a "J."*

Conversely, half the sample quantitation limit (SQLs) was used as a substitute concentration for non-detects when determining the average concentration for metals, pesticides, and PCBs (pg. 3-4). Diluted samples and samples with matrix interferences may have elevated SQLs which tend to bias high the average concentrations.

*It is true that the method employed of calculating average concentrations (using a value equal to half of the SQL for "non detects") results in a value which is biased "high." However, decisions regarding containment were made on the basis of contaminant concentrations which greatly exceeded the SQLs, in which case this degree of bias not important. It should also be recognized that averages were calculated merely for the convenience of the reader, to give some idea of the overall level of contamination among those areas selected for analysis. The reader has access to all of the data, and is encouraged to interpret the data as she or he feels appropriate.*

Visible product and high concentrations of contaminants are found to the farthest extent that sample locations have extended in the river. This indicates that planned site containment that is limited only to the footprint of the aquarium building may not be fully protective for preventing site- related contaminant release. Sediments outside the boundaries of the containment system would be fully exposed to resuspension by construction disturbance. This issue should be resolved and assurances provided that containment can be accomplished before decisions to proceed with construction are made.

*The silt curtain will be installed as one of the initial steps in the installation of the containment system. The presence of the curtain will serve to minimize turbulence and traffic which might originate from within the construction site. Outside disturbances related to contruction could result from boat traffic entering and exiting the construction site (through a "gate" in the silt curtain). This type of disturbance is considered to be significantly less disruptive than the routine channel and turning basin traffic which occurs on a daily basis at the site. It is clearly less disruptive than the periodic dredging which occurs immediately beyond the building line. The City will otherwise prohibit construction related disturbances from occurring outside of the silt curtain. These will be contained within the limits of the site and the silt curtain.*

**Comment 2. by LAW**

Pg. 1-5 - This section should mention that steel casings were required at 44 of 66 boring locations to mitigate contaminant migration.

# **Killam**

*The observation that 44 of 66 upland borings required the use of casing is discussed on page 2-2 of the report.*

## **Comment 3. by LAW**

Pg. 1-6, paragraph 3 - The PSI soil data for location B-32, which is presented in the Expanded Site Investigation Report, should be incorporated in the Killam report.

*The reader is referred to the cited report for related analytical data. This report was not intended to represent a compilation of the results of previous investigations.*

## **Comment 4. by LAW, DHEC**

Pg. 1-6 (upland soils) - This section should reference Section 2.0 for a discussion of field conditions encountered during the site investigation. We recommend tabulate and summarize the results of analysis of the product samples that were collected. The floating product, tar-like product, and creosote product should be included.

*The referenced section is an Introduction. Section 2.0 which is titled, "Field Sampling Procedures and Observations" follows immediately thereafter and discusses this subject at great length. We do not see the need for a cross-reference at this point.*

*Only one sample of product was collected. The City submitted this to a laboratory for "fingerprinting" analysis, which concluded that the product sample was best characterized as "mineral spirits." Otherwise, laboratory analysis was not required or performed on product samples.*

## **Comment 5. by LAW**

Pg. 1-8 - A discussion of data quality objectives and whether objectives were achieved should be included. In particular, the objectives associated with the groundwater and surface water investigation are not discussed.

*Specific data quality objectives were not required by the approved PSI Workplan, which defines the scope of the present investigation. However, Killam's QA/QC plan states that the field methods and equipment decontamination procedures used in the present investigation are considered to be Level IV methods. The evaluation of data quality was limited to the review of the laboratory non-conformance summaries, which is documented in Section 4.0 "Summary of Analytical Data Quality Review."*

## **Comment 6. by LAW**

Pg. 1-8, last sentence - No mention is made of whether spike results were within control limits. Is this information available from EPA?

*Killam has no knowledge of whether the results from these spiked samples are within control limits. Killam has not yet been provided with this information, although we understand that this data will be ultimately available through Bernie Hayes, EPA Region IV, Atlanta.*

**Comment 7. by USGS, NPS, NOAA**

A thorough analysis and display of the analytical data would be extremely useful. Data mapping, including display of vertical and horizontal location of samples along with associated concentrations, would significantly enhance the ability to understand the levels and distribution of contaminants within the site.

*Such an analysis and display of the analytical data was not included within the PSI Workplan for this investigation, to which the subject report responds. The reader is free to process or summarize the data, all of which has been included in the report appendix.*

**Comment 8. by LAW**

Pg. 3-1 - Based on recommendations received from the Ground Water Technology Support Unit, screening criteria should also include USEPA Region IV Waste Division Sediment and Saltwater Quality Screening Values. The sediment values should be compared to detected shallow soil and sediment concentrations. It is appropriate that constituents for surface water and ground water results not be screened out as a limited number of constituents were detected. A comparison to state and federal surface and drinking water standards and guidelines would be appropriate. Although the shallow ground water is not currently considered a viable source of drinking water, the State considers the ground water as potentially potable (Class GB). As ground water potentially discharges to the Cooper River, a comparison of ground water and surface water results to saltwater quality criteria should be included.

*The PSI Workplan requires the submittal of all generated data for review by the National Park Service and others. This data has been provided in the subject report. Users of this data are free to apply any screening criteria or regulatory standards which they believe to be appropriate. Any "screening" performed by Killam was done for convenience and for presentation purposes, rather than as a required element of the work.*

**Comment 9. by LAW**

Pg.3-1 - The use of ROD levels as screening criteria is not supported in the discussion. Did these sites have exposure pathways similar to those found at the aquarium site? Were ecological considerations similar to those of the aquarium site?

*The results from prior Records of Decision were used based on the technical similarities between those cases and the present investigation. Risk based levels generated at the Pine Street site were used a one of several sets of screening criteria. At Pine Street, the pathways via sediment are similar. However, in that case the environment was specifically aquatic rather than estuarine.*

**Comment 10. by DHEC**

Pg.3-7 - fourth paragraph - Please define an obvious source of PAH contamination from a historical and visual perspective.

*Historic sources of contamination include the former shipyard which existed at the site, former wood treating operations, and the former manufactured gas plant. Visual sources of PAH contamination include creosoted wood pilings which occur extensively throughout the site. The creosote use to treat the timbers contains high percentages of PAHs. "Treatment" results in the incorporation of substantial amounts of creosote (measured in pounds per cubic foot) into the timbers.*

**Comment 11. by LAW, DHEC, NOAA**

Section 3.0 - BTEX constituents are discussed in the document, but are not considered as constituents of concern and are not listed on Tables 3-2 through 3-7. These constituents should also be listed on the tables. BTEX in Horizon C were at levels significantly higher than Horizons A and B. Levels were above ambient water quality criteria or apparent effects thresholds for those constituents where values are available. Levels similar to Horizon C were observed in shallow and deep intertidal sediments, and to a lesser level in the subtidal sediments. This suggests that these contaminants potentially may be migrating through the sand aquifer into the river at levels of concern.

*All data were provided in the report as required by the PSI Workplan. However, in response to numerous comments requesting a summary of BTEX and dioxin data, tables summarizing this data have been compiled and are included in this document.*

*The comment further suggests that BTEX may be migrating to the Cooper River based on the data presented in the report for the various soil horizons and categories. It should be noted that levels of BTEX observed in groundwater are low and are much lower than were found in the associated soils. The ambient water quality criteria for benzene are orders of magnitude higher than the highest level found in the shallow groundwater (chronic - 700 ppb, acute - 5,100 ppb, versus max of 14 ppb in fill aquifer). Since any migration of BTEX would be occurring through groundwater, the data suggests that any such migration is minimal.*

Dioxin results should also be listed on Tables 3-2 through 3-7. Region III lists the residential soil risk-based concentration as  $4.1 \times 10^{-6}$  mg/kg for 2,3,7,8-TCDD (dioxin) or 0.0041 ug/kg, rather than 0.0043 ug/kg, as shown in Table 3-1. If this value is used generically for dioxins, several horizons exceed the screening value. The text discusses dioxin results in terms of micrograms per kilogram and nanograms per kilogram. The text should be consistent in the units listed. Calculation of the toxicity equivalency factor for 2,3,7,8-TCDD should be conducted using the full dioxin/furan scan analytical result.

*Dioxin data has been provided in the attached table. Calculation of the toxicity equivalency factor was not performed as it was not required by the PSI Workplan and is normally performed as part of the risk assessment process. The differing units for dioxin result from the use of Method 8280 or Method 8290, and are as reported by the laboratory. One microgram is equal to 1000 nanograms.*

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### **Comment 12. by LAW**

Table 3-1 - Region III lists the residential soil risk-based concentration for arsenic (as carcinogen) as 0.37 mg/kg. This level is lower than levels listed in Table 3-1. Also, no consideration is given to screening inorganic compounds versus background levels. Constituents occurring at background levels may be excluded as constituents of concern.

The table should note that the Region III value for chromium is for chromium VI and the cyanide value is for free cyanide. The most recent version of the Region III table is dated April 18, 1994.

LAW has previously received comments concerning the use of the proposed EPA sediment quality criteria. Several comments suggest that normalization to 1 percent organic carbon is inappropriate and suggest a value of 2 to 5 percent.

*While the cited 0.37 mg/kg level for arsenic is lower than the value cited in Killam's table, arsenic was not excluded by Killam's screening and was included in the Tables. The point is therefore moot. Background levels were not considered in the screening process. Killam acknowledges that the Region III value for chromium refers to the hexavalent form of this constituent, and that the cyanide value is for free cyanide.*

*According to Anna Poulton of the Region III EPA, the most recent version of the Region III Table is now dated July 11, 1994. This table is subject to frequent revision. For screening purposes, the version of the table use was recent and was judged to be adequate. The use of the Equilibrium Partitioning Approach commonly employs 1% for calculating the guideline criteria, as was done by Killam. This is more conservative than using a value of 2 to 5 percent.*

### **Comment 13. by LAW, DHEC**

General comment on Section 3.0 Tables - The "X" flag is inadequately explained.

*The full definition of the "X" flag by CompuChem Laboratories is as follows: Other specific flags and footnotes may be required to properly define the results. If used, they must be fully described and such description attached to the Sample Data Summary Package and the SDG Narrative. If more than one flag is required, use "Y" and "Z", as needed. If more than five qualifiers are required for a sample result, use the "X" flag to combine several flags as needed. For instance, the "X" flag might combine the "A", "B", and "D" flags for some sample. The laboratory defined flags are limited to the letters "X", "Y", and "Z".*

### **Comment 14. by LAW**

Section 4.0 - This section does not discuss potential bias which may be introduced in the data set. For example, many sample delivery groups required dilution for analyses. Dilution of the sample increases the sample quantitation limit and the potential for false negatives. When constituents of potential concern are detected in blanks or spike recoveries are biased high, false positives are more common. The level of uncertainty associated with the data sets should be presented in qualitative terms.

*Killam's review of the laboratory quality assurance/quality control data was limited to an evaluation of the laboratory non-conformance summaries, which was in accordance with the PSI Workplan and was documented in Section 4.0 of the report. To respond directly to this comment, matrix interferences did require the dilution of many samples which has the effect of raising the sample quantitation limit. This does increase the probability of false negatives (assuming that non-detects are set at zero). However, as we have stressed before, the key decisions regarding containment were made on the basis of the more highly contaminated samples in which this bias is not significant.*

**Comment 15. by LAW, USGS, EPA, SCE&G**

Section 5.0 - This section should be revised to incorporate data collected by the USGS. The next discussion concerning the application of a USGS ground-water flow model (MODFLOW) and pipe flow equations to determine the amount of ground water migrating into the second sand aquifer is not very clear. The MODFLOW model could be used to calculate the volume of water that would flow through a cross-sectional area of aquifer material under a given set of conditions (hydraulic conductivities, vertical conductances, time, etc). It is not clear, how the volume of water (17 gallons) was calculated or whether it is a valid number given the assumptions presented. Perhaps more detailed information on how the modeling was done would help us understand.

*The data collected by the USGS extends considerably beyond the limits of the present study. However, it should be noted that the downward gradient which was described in both the Killam report as well as the Chester report appears to vary with season and precipitation. According to Bruce Campbell, the gradient may be upward for limited periods of time. Of course, an upward gradient would counteract the tendency for contaminants to migrate downward which was evaluated in the present report. In other words, the downward gradient evaluated by Killam is the worst case condition regarding contaminant migration. Should an upward gradient be present for limited periods of time, this will mitigate potential releases to the sand aquifer. It does not appear that an upward gradient will exist naturally for a long enough period of time which would permit the construction schedule to take advantage of this gradient. However, the City plans to maintain such an upward gradient by a continuous dewatering process.*

*The purpose of the MODFLOW simulation was to determine how quickly the two aquifers would equilibrate given a certain size connection between them. MODFLOW was used to perform these calculations, because it provided a finite difference framework from which this problem could be solved. Killam acknowledges that this is not the typical use for MODFLOW. However, since none of the model's governing assumptions were violated, Killam feels that the use of MODFLOW in this context is not inappropriate. The details of the MODFLOW simulation are attached to this report.*

**Comment 16. by USGS, EPA, SCE&G**

Section 5.1 Regional Vertical Gradients p.5-2: This section describes the potential for a "cascading effect" which could draw the contamination from the surficial aquifer into the Middendorf aquifer, the top of which is 1800 feet below land surface. This is highly unlikely

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unless CHN-14, the Middendorf aquifer well located on the South Carolina Electric and Gas Company (SCE+G) substation, provides a direct conduit along the inside or outside of the well casing.

*Killam agrees with this comment. This section mentioning a "cascading effect" does not discuss contaminant transport, but rather an induced downward component to the hydraulic gradient. Killam is not implying that shallow contamination might reach the Middendorf aquifer, but that the pumping of the Middendorf could be contributing to a downward gradient which might be propagated to the surface, inducing contaminants to migrate from the fill aquifer into the sand aquifer located approximately 40 feet below grade.*

### **Comment 17. by USGS, SCE&G**

Section 5.2 Site Hydraulic Gradients p. 5-3: The section on tidal fluctuations indicates that a direct horizontal hydraulic connection with the Cooper River is responsible for the water-level fluctuations observed in the deepest wells at the site (USGS-1, USGS-2 and MWKA-1). While the connection may contribute to the fluctuation the main cause is tidal loading on the confined aquifer skeleton that results in a rise or fall in water levels in a well. CHN-14 exhibits the exact same response in the water levels recorded there only they are on the order of 1-2 feet due the higher degree of confinement of the Middendorf aquifer.

The April 11, 1994 synoptic water-level measurements discussion is in agreement with our conclusions that the concrete culvert drainage structure has little influence on the water levels of the shallow aquifer on the Dockside II site. However, our water-level recording equipment on USGS-2S gave a 24 hour average water level of 2.51 feet above mean sea level (MSL) and on USGS-2 of 1.75 feet above MSL.

The discussion of the May 5, 1994 water-level measurements presents several problems. The text indicates the highest water level collected was at MW-11 2.71 feet above MSL. Table 5-3 indicates the highest water level of 4.17 feet above MSL in USGS-2S. The difference between MW-6 and MW-9 is 0.06 feet not 0.01 feet. The water-level recording equipment on USGS-2S gave a reading of 2.09 feet above MSL on the morning of May 5, while Table 5-3 indicates a water level of 4.17 feet above MSL. A water-level elevation of 4 feet or more at USGS-2S would be similar to the levels collected in the winter when there was fairly high rainfall.

*Tidal loading certainly does play a role in the ground water's tidal fluctuations, and the greater fluctuations observed in the SCE&G well are probably due to that aquifer's greater confinement. However tidal efficiencies usually vary from 25 to 75%, whereas the tidal efficiency observed on-site is less than 10%, suggesting that other mechanisms are attenuating the tidal loading in the shoreward direction. How quickly the tidal signal is attenuated is a function of the transmissivity and storativity of the material between the body of water and the observation well. It is likely that dredging the channel removes some of the lower permeability materials and thus increases the amplitude of the fluctuations observed in wells of intermediate depth. Presumably, the more shallow unconfined materials would be characterized as having a greater storativity,*

*and therefore water levels in wells installed in these materials would have smaller fluctuations in response to tidal loading.*

*This issue of a discrepancy between water levels hand-measured by Killam and those recorded by USGS' logging machine at USGS-2S was raised in the telephone conversation of July 12, 1994, between Bruce Campbell and Bob Starcher of Killam. It was agreed at that time that the reference elevation point used by Killam (USGS' reported casing elevation of 8.23 ft MSL) was different than the one the USGS data logging machine used. After reviewing the data over the phone, Mr. Campbell stated that he was satisfied that Killam's measurements had been taken properly.*

*The text states that a hydraulic mound exists on site and that MW-11 is "the highest point in the hydraulic mound." This is not meant to imply that the level measured at MW-11 was the highest point measured overall. Killam acknowledges that the correct value for the difference in heads between MW-6 and MW-8 is 0.06 ft as shown in Table 5-3, not 0.01 ft as stated in the text. Please note that this error is only 0.05 ft and that Killam's conclusions remain the same.*

**Comment 18. by USGS, EPA, SCE&G**

Section 5.4 Contaminant Migration Scenarios p. 5-5: In the first paragraph, there is mentioned a strong downward component to the vertical hydraulic gradient between the two surficial aquifers. The continuous water-level data collected from USGS-2 and USGS-2S demonstrates that this is not always true. The downward gradient reversed to an upward gradient from May 20 to June 11 at the end of an extended period with little rainfall (see enclosed figure).

In the next paragraph, mention is made of hypothetical situation of a small pocket of contamination being released to the Cooper River that would not significantly increase the ambient contaminant loading of the river. How was this determined?

The next paragraph states that if a borehole collapses after it is pre-augered it would present an effective barrier to migration of dissolved contaminants. This would be the case if the lower sand unit collapsed. If the upper fill aquifer collapsed, it could fill the borehole with potentially heavily contaminated material which would be pushed into the lower sand aquifer as the pile is driven.

*While Killam acknowledges that an upward gradient is possible, it does not change our conclusions which are based on conservatively assuming the worst case, which is the documented occurrence of a downward hydraulic gradient.*

*The word "significantly" was not used in a statistical sense, but rather as an expression to convey the huge difference in mass between ambient contaminant loading of the Cooper River and any small pocket of hydrocarbon that might seep down an open auger-hole.*

*Killam does not dispute that a collapse of the upper fill material into an open borehole could introduce contaminated material into the lower sand aquifer (if the borehole is open between the*

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*fill and the sand aquifer), nor is it implied anywhere in the text that this could not happen. To summarize, boreholes which do not collapse will permit passage of water through the borehole in response to prevailing gradients. If the site is being dewatered, the gradient and water movement will be upward, retarding any tendency for dissolved contaminants to migrate. Boreholes which partially collapse may restrict the passage of water, and may result in solid or dense liquid phase contaminants moving downward (under certain conditions). Complete borehole collapse will minimize any movement of water, soil or product.*

### **Comment 19. by DHEC, SCE&G**

Pg. 5-5 - The constituents present in MW-KA1 may have been introduced during well construction. It is highly unlikely that the aquifer is clean because of flushing, as the constituents of interest are persistent, they have a tendency to adsorb to soils, and have low solubilities. The screen depth of MW-KA1 should be compared with depths of observed soil contamination to determine if the well is screened within a contaminated portion of the aquifer.

*Appropriate procedures specifically designed to prevent cross-contamination were followed by Killam during the installation of MW-KA1. Of course, there is always some possibility that cross-contamination can occur in spite of these efforts. We feel that the probability that the contaminants which were detected in the sand aquifer originate from cross contamination induced by the monitoring well is very low. Killam feels that the higher degree of water transport in the aquifer may be one factor which accounts for the concentrations of contaminants observed, along with the inherent low solubility of those contaminants.*

*Screen placement for MW-KA1 was intended to intersect the sand aquifer, in accordance with the approved PSI Workplan, and the well, in fact, does intersect this layer. A review of the soil boring logs included in the report will reveal numerous instances in which hydrocarbon product (sheens, globules, product) was encountered in the boring intervals which intersect the sand aquifer.*

### **Comment 20. by DHEC, EPA, SCE&G**

Pg. 5-5, third paragraph - Although hydrocarbon product is present at depth, it is not uniformly distributed in the aquifer. The screened interval in the deeper aquifer indicates only traces of constituents suggesting that there may be a layer of relatively clean water within the aquifer. The drilling of the pre-augered holes would allow migration of material into this interval. It is possible that the floating product in the water table aquifer, which is denser than air, could migrate to this clean interval in the sand aquifer through the open hole in addition to any dense product that may be present. The report indicates the deeper aquifer discharges directly to the Cooper. As a result, migration of product into the deeper aquifer would likely increase the dissolved and separate phase contaminant loading in the Cooper River. A pocket of product may dissolve slowly so that the impact would be long lasting. Although the writers of the report may not view this as significant, it does appear significant from an environmental perspective. This comment also applies to the second paragraph on page 5-7.

It should be noted that none of the shallow wells in the aquarium area bracket the water table; therefore, the free product that was encountered floating on top of the water table is not present in the wells. Sampling of the upper portion of the water table aquifer might indicate higher concentrations of constituents relative to the existing wells. Therefore, when potential impacts of construction are determined, the presence of product floating on the water table should be considered. Because the well in the underlying aquifer indicated a lack of impact, cross-contamination of the lower aquifer by migration of floating product or other free product through a preaugered hole is a concern.

*The comment reflects a concern over the possibility that product at shallow depth will fall through an open dry borehole, and come to rest in the sand aquifer where it will be a continuing source of dissolved and free phase contamination. Further, the comment hypothesizes that significant loadings of contamination will be imposed on the Cooper River as a result.*

*First, the water table is present at very shallow depth through most of the site. Therefore, we feel that the borehole will be water filled at all times. Therefore, light product, which floats on water, cannot sink through the borehole. Upon removal of the augers, a variety of scenarios are possible, depending on specific soil conditions at that borehole. These include an open borehole, a partially collapsed borehole, or a completely collapsed borehole.*

*If the borehole remains open, it is unlikely that significant amounts of product will be discharged to borehole as free falling product globules, given the scattered occurrence of product noted in the field investigation. Rather, product (if present) will likely ooze onto the surface of the borehole and, given a sufficient amount, may "drip" down the wall of the borehole (and then only if the product is denser than water). A pile which is then inserted and driven down the borehole may then "smear" the product in a downward direction, which is described in the report. If the product is less dense than water (as implied in the comment), it will remain at or near the surface.*

*If the borehole partially collapses, it may block the borehole at one or more locations. These blockages will tend to retard the potential movement of product downward. Only if the blockage occurs in the sand layer, not above it, and fill material collapses and falls through an unobstructed borehole, would contaminated material from the fill layer come to rest in the sand aquifer. If the borehole collapses more completely, downward movement of product or soil would be greatly restricted.*

*While it is certainly possible, over a total of 270 preaugered boreholes, that additional hydrocarbon contaminated soil or product may be introduced into the sand aquifer, the observation that product is already present at depth with little impact on water quality in the aquifer should be considered as a mitigating factor. Finally, the quality of the groundwater in the sand aquifer will be carefully monitored during the preaugering program, with special emphasis on an early warning well to be installed in conjunction with the first group of piles to be preaugered and driven.*

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*Discussions of the mechanisms which will likely occur during this process have indicated that in driving the pile through the clay layer which separates the upper fill from the sand aquifer will cause the formation under the clay to be sealed by clay particles which are smeared downward by the pile. This may act to retard the migration of contaminants from the borehole into the formation.*

*Regarding the comment that wells in the upper portion of the water table might be more contaminated than MW-8 and MW-11 which were sampled, it should be noted that these wells are screened over a depth of thirteen and fifteen feet respectively, and are within the approximately 20 foot thick fill aquifer. Therefore, these wells can be expected to provide water samples which reasonably represent the quality of the water occurring in the water table aquifer.*

### **Comment 21. by NPS, DHEC, NOAA, W&MRD**

Pg.5-8 - Removal of the debris may free the shallow aquifer to discharge directly to the Cooper. If the construction alters the hydraulics of the fill aquifer such that it is open to and connected with the Cooper River, it will be difficult to contain the contamination and product that may be released. Any attempt to restrict the migration of shallow water to the Cooper should be a permanent solution. Although the timber wall may contain the material initially, its long term effectiveness is in question.

*The report indicates that the discharge of the water table aquifer to the river is restricted due to tarred sands and a thinned aquifer cross-section. The effect of the debris per se is questionable. Removal of the debris behind a containment barrier and the replacement of debris with fill is not expected to result in significant increases in groundwater discharge or contaminant discharge. Over time, any newly placed fill will become tarred and serve to restrict the discharge of groundwater. This will occur prior to degeneration of the timber wall.*

How the construction will affect the hydrology and flow of groundwater to the river is not fully understood. Consequently, it is difficult to know whether or not the proposed groundwater containment can fulfill stated design objectives. Thus, it is imperative that groundwater monitoring be adequate to detect any increase in contaminant discharge and that contingency plans be in place to respond to any release that does occur.

*Killam agrees with this comment. Shallow groundwater currently discharges contaminants to the river, therefore, containment mechanisms to avoid increases in discharge have been included in the containment plan. Groundwater in the sand aquifer will be monitored through a demonstration pile program as well as by conventional monitoring wells. Additional measures to restrict migration of contaminants to the sand aquifer will be employed if the demonstration pile program indicates that these are necessary.*

### **Comment 22. by LAW, DHEC**

Section 6.0 and 7.4 - Volatile compounds were detected in the surface and subsurface soils. Monitoring for volatile organic compounds within the worker breathing zone should be specified in the construction Health and Safety Plan. Real-time monitoring at the perimeters of the

construction site for volatile organic compounds and total particulate is recommended during the period of construction. The results of the perimeter monitoring should be used to document that control measures are adequate and off-site vapor and particulate emissions are within acceptable limits. The contractors should be prepared to upgrade personal protective equipment and construct dust/vapor barriers if unacceptable levels of VOCs or dust are encountered during construction.

*Air quality monitoring is addressed in Section 5.2 of Killam's Environmental Monitoring and Response Plan (July 1994). More detailed information is provided in the Section 1.7.C.9 of the Health and Safety Plan Specification (July 1994) and Section 1.6 of the Air Containment Specification (August 1994). These documents provide for monitoring of organic vapors, oxygen/combustible gases, and particulates in the work area, and monitoring for particulates at the perimeter. In addition, the Monitoring and Response Plan will be modified to include perimeter sampling on three days in which odors are noted on-site. Monitoring will be via Summa Cannister for volatiles and PAHs. The data will serve to document the level of perimeter exposure. Proper responses to elevated levels are detailed in Section 5.4 of Killam's Environmental Monitoring and Response Plan (July 1994) and Section 1.5 of the Air Containment Specification (August 1994).*

Because the construction site is adjacent to the Calhoun Park site and evidence of contamination at the aquarium site is documented by the report, the construction contractors may be required to use OSHA-trained workers. Occupational health and safety officials with the State of South Carolina should be consulted for further guidance.

*Killam agrees that the construction workers who will be working within the areas defined as the Exclusion Zone and the Contaminant Reduction Zone must have received appropriate OSHA training in accordance with 29 CFR 1910.120. This requirement is detailed in the Killam's Health and Safety Plan Specification (July 1994).*

Subsurface soils may be brought to the surface during construction and site grading. The City should consider the removal of surface soils around the building and replacement of soils with clean fill. After construction, landscapers will come into direct contact with soils surrounding the building. Installation of clean fill should reduce potential future exposures for landscapers maintaining the grounds of the aquarium. The clean fill cover would also lessen concerns for aquarium visitors, terrestrial animals, flora, and migratory birds which may come into contact with surface soils surrounding the building.

*Killam agrees that certified clean fill and/or top soil should be used when the site is brought to final grade and permanent vegetation is emplaced.*

Installation and maintenance of utilities for the aquarium may also be a pathway for future soil exposure. The City should develop health and safety guidelines protective of utility workers which may be exposed to remaining surface and subsurface soils.

*Killam agrees that a Health and Safety Plan for workers who will contact subsurface soils over the long term is appropriate.*

**Comment 23. by LAW, EPA**

Sections 6.1 and 6.3 - Materials that will be excavated during aquarium construction are contaminated with numerous constituents that are presumably the result of releases from the Calhoun Park Area Site. As such, the disposal of these materials should be accomplished in the same manner as if they are waste materials generated by investigations or remedial actions undertaken at a Superfund site. These materials should be characterized in an appropriate manner so that acceptable disposal alternatives can be determined and implemented.

*Killam agrees with this comment.*

**Comment 24. by LAW, NOAA, W&MRD**

Section 6.4 - It is unclear how sediments contained during construction are to be removed and disposed of following construction.

*Sediment which is collected in on-site drainage structures, and soil which is generated from excavation, drilling or grading will be staged on-site, sampled for waste classification, and will be disposed of in accordance with current SCDHEC regulations. It is anticipated that this material will be disposed of as non-hazardous solid waste.*

An additional concern regarding this project is any consideration of the sand blanket becoming a permanent feature of a future remedy for the site. Because the extent of site related sediment contamination has yet to be fully characterized, the proposed sand blanket will address only a portion of the potential area of sediment remediation. Consideration of this action as a permanent remedy seems very premature with regard to preparation of a baseline risk assessment, remedial alternative selection, and site remediation. This seems especially true in consideration that future plans for development of the adjoining areas will involve dredging immediately adjacent to the aquarium site.

*The sand blanket has been proposed as a containment measure. It is likely to be effective as an interim or permanent remedial measure as has been demonstrated by case studies furnished by the City. However, the use of the sand blanket for containment does not preclude the implementation of other remedial measures in the future. Other remedial measures, might be somewhat more costly to implement based on the presence of the building and the need to remove the sand blanket.*

**Comment 25. by LAW, NOAA, USGS**

Section 6.5 - How is pumped groundwater to be contained on the site? What are the discharge limits for disposal of pumped groundwater? What volume is anticipated?

*Pumped groundwater will be stored on site in drainage basins constructed by the contractor. Discharge limits will vary depending on the manner in which the water is to be disposed. The*

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*specific disposal point for collected groundwater will be selected by the contractor. The testing procedures, and any required treatment of groundwater will be determined by the requirements of the disposal facility. However, it is expected that a likely disposal point for water generated on-site will be the local sewerage facilities. Contaminated water generated at the site may meet required influent limits with pretreatment in the form of oil/water separation. An estimate of the volume of groundwater to be collected during construction can be determined when a specific construction strategy is developed by the contractor.*

Pg. 6-3 - In the third paragraph, it is stated that the shallow fill aquifer has a restricted discharge to the Cooper River due to "tarred" sediments mentioned earlier in the report. This will not restrict the discharge only redirect it. The aquifer is continuously recharged by rainfall so the ground water flowing through the aquifer has to go somewhere and it will flow around this "tarred" area and discharge into the Cooper River.

*Redirection of the discharge will serve to increase the length of the migration pathway, increasing build-up of head and decreasing the flow rate, thereby restricting the discharge.*

### **Comment 26. by LAW**

Section 7.3 - How are vehicles and equipment to be tested to insure adequate decontamination was accomplished by steam cleaning or high pressure wash? The presence of PAHs, dioxins, and PCBs in the soil may require additional processes for equipment decontamination.

*Vehicles and equipment will be spot checked by the Environmental Inspector. This testing will be done on a visual basis, which is the most practical method of controlling this operation. It is felt that the proposed methods of decontamination are appropriate.*

### **Comment 27. by LAW, NOAA, W&MRD**

Pg. 7.1, para. 7.0 - Referencing Table 2-1 "Summary of Hydrocarbon Products/Sheens Observed During Installation of Soil Borings", 67 of the 91 soil borings and 14 of the 20 sediment samples indicate either sheens (often heavy), oil globules, or free product encountered in the first 20 feet of site upland, intertidal, and subtidal soils/sediments. This is indicative of a wide area of hydrocarbon contamination and influences all soil horizons. The level of protection provided by this plan should therefore reflect a high risk of release of contaminants as a result of excavation, grading, augering, and pile driving activities. Monitoring and response activities should be approached accordingly.

*Killam agrees with this comment.*

### **Comment 28. by LAW, DHEC, NOAA, W&MRD**

Pg. 7-1, para. 7.1.1, Sand Blanket - How will filtered sediments trapped within the sand layer be evaluated for potential contamination, and for removal of sand/sediment found to be contaminated as a result of testing?

*Filtered sediments within the sand blanket will not be tested for contamination, nor is the removal of the sand blanket planned following construction. To the extent that the sand blanket traps underlying sediment, it is serving its function in containing contaminants. Following the completion of construction, migration of sediments or soils upward through the sand blanket is not expected to occur unless the integrity of the sand blanket is breached by external forces.*

Sand coring procedure should be described in greater detail. It is assumed that this sampling is proposed for the subtidal area only. Numbers and locations of core samples as well as the sampling methods should be provided. The frequency of sampling should be based on time intervals between sampling events, not on an absolute number as stated in the monitoring and response plan. We recommend that sand corings be taken weekly during the construction period. As a minimum, analyses for PAHs, PCBs, and selected metals should be performed.

*The comment suggests that more frequent testing of the sand blanket be conducted than the two sampling episodes which were proposed. Further, the comment suggests analytical testing of the sand cores. It is expected that the sand blanket will be stable and will not move or be eroded over a short period of time. Therefore, the frequency of sampling proposed in the Monitoring Plan was judged to be adequate. To satisfy the concern expressed in this comment, the City is evaluating the possibility of modifying the Monitoring and Response Plan to incorporate the use of a diver on a weekly basis. Five stakes will be placed at subsurface locations within the area occupied by the sand blanket. These will be visually checked on a weekly basis to determine if any movement or erosion of the sand blanket is occurring. If significant changes are noted, the sand blanket will be replenished as needed.*

*We will also make a revision which provides the Environmental Inspector the discretion to require additional testing or inspection based on the occurrence of a major storm, or other event which might be judged to potentially compromise the integrity of the sand blanket.*

*With regard to testing of the sand blanket for contaminants, Killam does not feel that such testing is appropriate provided that the visual inspection of the sand cores confirms that the sediments are not migrating into the sand layer more than six inches. If the visual inspection indicates the migration of sediment, product, or other visual indications of contaminants, then selected samples of the sand core will be submitted to the laboratory for analysis. Analyses will be performed for PAH and selected metals. The selection of samples for submission to the laboratory will be subject to the discretion of the Environmental Inspector.*

**Comment 29. by LAW**

Pg. 7-2, first paragraph - Figure 7-1 does not show the two elements indicated to comprise the sand blanket, i.e., fine gravel and sand layers, as stated. Will the gravel layer also be extended into the intertidal and subtidal areas?

*Filtered sediments within the sand blanket will not be tested for contamination, nor is the removal of the sand blanket planned following construction. To the extent that the sand blanket traps underlying sediment, it is serving its function in containing contaminants. Following the*

*completion of construction, migration of sediments or soils upward through the sand blanket is not expected to occur unless the integrity of the sand blanket is breached by external forces.*

**Comment 30. by LAW, NOAA**

Pg. 7-2, Silt Curtain - Will this curtain be designed to adjust to tidal elevation changes, or will it suspend above the water surface during low tide? Will the bottom of the silt curtain, ballasted with chain, be attached to the H-beam piles to prevent "fanning" of the silt/sand bottoms due to wave and current pressures? NOAA recommends that diver inspection of the curtain be performed daily during the construction period. If damage is noted, operations should be temporally halted until repairs have been completed.

*The containment curtain (or turbidity barrier) will be designed to adjust with tidal elevation changes and will be fixed to the bottom of the H-pile. A ring attached to the top of the curtain will ride up and down the H pile to allow for vertical movement. The bottom of the curtain will be ballasted with a 5/16" galvanized chain attached to the H-piles to prevent fanning of the curtain between piles due to wave and current movement.*

*The comment questions the method through which the integrity of the subsurface portion of the silt curtain will be determined, and suggests that daily inspections by a diver be performed. In many cases (in which the silt curtain encloses turbid water) Killam feels that the breaches in the subsurface portions of the silt curtain can be identified by the observation of increased levels of turbidity in the water. In the present case, the City team agrees that inspection by a diver on a weekly basis, or more frequently as determined by the Environmental Inspector, would be a worthwhile addition to the Environmental Monitoring and Response Plan, and the City is evaluating the feasibility of making this change.*

**Comment 31. by LAW, DHEC, NOAA, USGS, W&MRD**

Pg. 7-2, last paragraph - As indicated on site boring logs, silts and clays occur throughout the future construction area. Silt and clay particles are less than .074 millimeters in diameter, and will pass a U.S. Standard Sieve 200, and, therefore, will pass a sieve size 100. Silt particles suspended as a result of construction activities within the subtidal area would likely pass through the proposed silt curtain. Those that do not may gradually settle to the surface of the sand blanket. Tidal action and wave actions would likely resuspend these settled fines. If monitoring (based on turbidity) indicates a release, what response will be taken for sediment already in the river waters?

*The sand blanket's primary purpose is to confine the potentially contaminated silt and clay particles on the river bottom so that they are not suspended into the water column during pile driving. Any sands that are suspended during construction will be contained by the turbidity barrier provided with a U.S. Standard Size 70 Sieve.*

Laboratory turn-around time of one week will not allow rapid implementation of a necessary or appropriate response.

*In response to numerous comments seeking a more rapid turnaround of the weekly water quality samples, the City is evaluating a change in the Monitoring and Response Plan which would provide 72 hour turnaround time for water quality samples. The deliverable at 72 hours would be faxed laboratory data.*

It is not possible to minimize the amount of ground water discharge with sheet pilings only to redirect it. The only way to lower the amount discharging into the river is to pump it out of the aquifers before it reaches the Cooper River. Same comment applies to the section on Additional Ground Water Flow Barriers. The ground water will reach the river unless it is pumped.

*As was commented on earlier, redirection of flow requires a longer migration path which serves to restrict the discharge. The objective of the groundwater containment plan is to avoid increasing the discharge to the river. This purpose is served by flow barriers, which is the function currently served by the presence of tarred sands at present.*

**Comment 32. by LAW**

Pg. 7-4, paragraph 5. - Hydraulic placement of the sand blanket within the subtidal area will disturb the sediments within this area. Sediment sampling results indicate elevated levels of PAHs and other compounds at depths likely to be disturbed. What response action is planned for releases caused by this activity?

*The containment structure will be constructed first followed by the placement of the timber retaining structure. There will be a total of approximately 45 H-piles for the containment curtain and the timber lagging wall. Piles will settle under their own weight and the weight of the hammer and each pile has a low area of displacement. The fill placed behind the timber lagging wall will allow the contractor to work in the dry and minimize disturbance to the sediment. The sand blanket will be placed after the timber lagging wall is complete. Landside equipment operating from the top of the sand blanket will be maximized. Vessels used for pile driving will be shallow draft barges with no spuds. Submerged diffusers are to be used for spreading the placed fill and will be specified in the contract document.*

**Comment 33. by LAW, DHEC**

Because floating product was discovered on top of the water table, disposal of the water/product generated during dewatering could be difficult. If the water has to be treated before disposal, a pre-treatment permit will be required. What volumes of water are estimated for the dewatering of the areas surrounded by sheet piling?

*Killam agrees that the disposal of water contaminated by product may be costly and may require permitting. Pumped groundwater will be stored on site in drainage basins constructed by the contractor, or in vessels. Discharge limits will vary depending on the manner in which the water is to be disposed. The specific disposal point for collected groundwater will be selected by the contractor. The testing procedures, and any required treatment of groundwater will be determined by the requirements of the disposal facility. An estimate of the volume of*

*groundwater to be collected during construction can be determined when a specific construction strategy is developed by the contractor.*

**Comment 34. by LAW**

Pg. 7-4, - What is the planned removal sequence for the containment system elements? The potential for disturbance of contaminated sands or sediments by removal activities is significant, and the responses appropriate for potential disturbances should be addressed.

*At this time, the removal of the waterside containment system elements, beyond the removal of the silt curtain, is not proposed. The sand blanket and timber lagging wall will remain in place. The removal of the silt curtain and associated boom is not expected to be significantly disruptive.*

**Comment 35. by SCE&G**

Pg. 7-6 - A 15x30 foot gavel decon pad is specified. Greases, solvents and other contaminants may be a potential source of leaching since no apparent specification was indicated to isolate these materials.

*No greases, solvents or other contaminants will be used in the decon process. Therefore, only those contaminants which originate on the site will be washed back into the stormwater collection system.*

**Comment 36. by LAW**

Pg. 7-6, paragraph 3 - Installation of a stormwater collection system/channels would encounter contamination, based on the relatively shallow depths of contamination encountered during the site investigation. What type of collection/drainage system is expected to be used for stormwater collection --- drop inlet drains, piping, ditches, etc.? How will soils excavated during trenching or ditch construction be stockpiled, tested, and disposed if contaminated?

*Regarding the need for OSHA trained workers for installation of the stormwater collection, Killam agrees with this comment. The specific construction details of the stormwater collection system will be proposed by the contractor. Soils resulting from excavation, grading, and drilling will be staged on-site, tested for waste classification, and will be disposed of in accordance with SCDHEC regulations.*

Pg. 8-2, Section 8.2 - What volumes of stormwater are anticipated to be collected, and how is the containment basin to be constructed? Anticipated volumes of stormwater must also allow for contaminated tidal influents in ditches or drainage structures.

*The stormwater containment basin will be designed and constructed by the contractor. It is expected that this system will contain runoff falling on that portion of the aquarium site which is upland of the timber lagging wall. Tidal influents are not anticipated.*

**Comment 37. by LAW, NOAA, W&MRD, SCE&G**

Characterization of background water quality conditions prior to construction operations should be described in greater detail. No mention is made regarding sampling procedures such as the number of sample stations, number of samples per station, sample locations and depth, tidal stage, or other water quality parameters. In addition to PAHs and metals of concern, total PCBs should be included as an analyst for these analyses. Also, Total Suspended Solids (TSS) should be measured in all samples on which chemical analyses are performed and the same stations as recommended for turbidity measurements should be used. As with background water quality characterization, sampling procedures to be used during construction operations also should be described in greater detail.

*The comment suggests that the background water quality characterization be described in greater detail and suggests that the same sampling stations be utilized as in the turbidity monitoring program. In response to this comment, Killam will modify the Monitoring and Response plan to indicate that for each of three weekly sampling events that one sample will be taken during the flood and ebb stages of the tidal cycle. Three sampling stations will be used, and these will be the same as the upstream, downstream, and on-site stations identified in the turbidity monitoring program. The analytical suite will not be expanded to include total PCBs. In the subtidal area, the average levels of PCBs were found to be much lower than the ERM level. Most of the sediments had non-detect levels of PCBs. In deference to the comment, however, one sample will be analyzed for PCBs every week of the baseline monitoring period. TSS will be measured in all samples. Samples will be taken from the mid-point of the water column.*

*The comment further suggests a higher level of water quality monitoring during the construction period. Killam will modify the Monitoring and Response Plan to indicate that two stations will be monitored on a weekly basis. These will be the same upstream and downstream stations mentioned above. Sampling procedures and the analytical suite will be the same as for the baseline sampling program. One sample will be analyzed for PCBs every two weeks.*

*Killam does not agree that all construction activities are intrusive. For example, work within the Aquarium building is not at all intrusive. The Environmental Inspector will make a judgement regarding the point in the actual construction period when intrusive activities are completed.*

As a part of the pre-construction phase baseline monitoring for total suspended solids(TSS) and turbidity, data should be gathered hourly over several tidal cycles to characterize changes in turbidity and TSS associated with tidal currents. These data, together with the observations proposed in the plan, can be used to establish a much better background data set for comparison with operational conditions during construction. The specific locations of the proposed sampling stations "upstream" and "downstream" should be identified; the distances of these stations from the work site should be minimal. We recommend three additional stations be established outside the silt curtain. One location should be positioned midway along each of the three sections of the silt curtain surrounding the area.

*The comment suggests that the baseline monitoring phase for total suspended solids and turbidity should incorporate hourly sampling over several tidal cycles in order to determine if changes in turbidity occur in response to tidal currents. Killam accepts this comment and will revise the Monitoring and Response Plan to incorporate hourly sampling over three tidal cycles (12 hours each). The specific locations of the sampling stations are best specifically identified prior to the implementation of this program. They will be located no further than 200 feet from the silt curtain.*

*The comment further suggests that three additional sampling stations for turbidity be established, each of which is located at the midpoint of the each section of the silt curtain. This comment is accepted. The stations will be located approximately 20 feet from the silt curtain at the midpoint of each of its three "faces."*

Turbidity action level #2 should be abandoned. Action level #1 addresses turbidity control only and establishes an upper boundary at 50% level above background as a water quality condition; the basis for this value is not discussed. Action level #3 addresses contaminant loading and, assuming that TSS/contaminant correlations can be established, can be used to establish an upper boundary for contaminant concentrations in receiving water. Therefore, exceedance of either of these two action levels should be used as conditions to initiate appropriate response actions.

*The comment suggests that the turbidity action level which permits an increased level of turbidity of 50% over the real time upstream turbidity level be abandoned since upstream turbidity may be influenced by construction related activities. Killam does not accept this comment since sufficient data will be generated in order to evaluate whether construction activities are having a significant impact on upstream turbidity. If this action level were dropped, it is likely that construction would be halted as a result of off site events, or storm events which have nothing to do with the aquarium construction. This will result in project delays and costs.*

*The comment further suggests that if either Action level #1 (50% over baseline) or Action level #3 is exceeded, then a corrective action would be triggered. Killam does not accept this comment since doing so may not permit any increment above baseline to occur. In fact, the baseline level could be determined to exceed the action level #3. Please note that Action Level #3 will determine the suspended solids load in the river during baseline conditions, and will ascribe to those solids the contaminant concentrations found in the upper sediment layer. In reality, suspended solids in the river result from contributions from the entire watershed and are likely to contain a lower concentration of contaminants. This gives Action Level #3 a very conservative bias.*

The need to insure that biologically relevant detection limits are used so that data obtained is meaningful.

*Killam assumes that this means the corresponding trigger levels. In our opinion, the Practical Quantitation Limits for PAH should be at the appropriate levels. However, achievable detection limits for metals may be questionable since the metals which are normally found in water with*

*a high salinity present positive interferences for the ICAP methods which are used in this analysis. The resulting data will need to be evaluated in this context. This will be discussed with the laboratory in order to determine if an alternate method (Atomic Absorption) can meet these levels without interferences.*

**Comment 38. by LAW, NOAA, DHEC, W&MRD, USFWS**

This site will be subjected to much physical disturbance through debris excavation, pile driving, and overall construction activities. Because of these disturbances, the high level of contamination present, and the potential for a release to occur, documentation is needed that demonstrates that the conceptual and engineering design of the sand blanket is sufficient to meet containment objectives.

*Significant documentation has been provided to the agencies with regard to previous uses of the sand blanket for containment and remedial purposes.*

**Comment 39. by DHEC**

Several PAH compounds are volatile but may not be detected by standard air monitoring equipment. A professional evaluation of whether PAH vapors would be detected and what percent response could be anticipated for the compounds should be included in the health and safety plan which should be approved by a certified industrial hygienist. It may be appropriate to do air sampling for PAHs when odors are noticed to determine if an exposure has occurred.

*The comment questions the ability of "standard" air monitoring equipment to detect volatile PAHs. This is a good comment in that HNu meters, which are commonly employed for real-time monitoring of volatile organic vapors lack the ionization potential to detect a number of semi-volatile compounds. The air monitoring plan will be revised to require the use of photoionization instrumentation (such as the HNu) or flame ionization instrumentation, as appropriate, to detect volatile emissions from work areas on the site.*

*In response to the second part of this comment, the City will consider a revision in the Air Monitoring Plan which would require that perimeter samples be collected on three separate days using a summa cannister and be analyzed for volatiles and PAHs. This will be done during intrusive work activities when odors are present. This sampling will document the levels of exposure during this phase of the work.*

**Comment 40. by DHEC, W&MRD**

The plan should address concerns about monitoring and containment of constituents that may sink and travel along the sediment/sand blanket interface until discharging into the river.

*Killam does not feel that it is likely that contaminants would travel between the sand blanket and sediment interface and then discharge to the river.*

**Comment 41. by DHEC**

Please provide an estimate of the total amount of soils per location that will be brought to the surface as a result of pile driving/preaugering.

*It is not anticipated that pile driving in the subtidal area will bring soils to the surface. For piles which are preaugered, an estimate of the soil volume which will be brought to the surface can be approximated by the volume occupied by 270 cylinders, 18 inches in diameter and 80 feet long. This is equal to approximately 1,413 cubic yards of soil. It is likely that the actual volume of soil to be generated will exceed this somewhat due to decompaction of the soil during drilling and localized collapses of the borehole.*

**Comment 42. by DHEC**

Please provide an indication of how impermeable the building bottom will be to vapors. It is understood that the bottom of a portion of the building will rest in close proximity to the remaining contaminated soils.

It is expected that the building slab, which is approximately 12 inches thick, will be completely impermeable to vapors.

**COMMENTS ON DRAFT ENVIRONMENTAL MONITORING AND RESPONSE PLAN**

**Comment 43. by LAW**

Section 2.3 - The plan to correlate total suspended solids(TSS) to turbidity measurements appears to be of limited value. No alternative is discussed in the eventuality that TSS cannot be calibrated against turbidity measurements. The correlation between constituent releases and TSS may not be quantifiable and would vary according the area of construction activity.

*If TSS cannot be correlated with turbidity, then Action Levels #1 and #2 would apply.*

Monitoring for chemicals of concern,i.e., metals and pesticides, appears to be the more appropriate course. Based on phone conversations with vendors, a validated field test kit for PAHs in a water media is not currently available. However, the soil method may be adaptable to filtered particulate or to a water matrix. The possibility of in-the field screening test kits and expedited turnaround time at the off-sight laboratory should be considered further.

*As indicated previously, the City is evaluating the imposition of a 72 hour turnaround time with respect to the analysis of the subject samples. This can be obtained from commercial laboratories at a premium cost.*

**Comment 44. by LAW, W&MRD**

Section 2.4 - Background levels should be considered in setting the monitoring protocols. What will be the source of the background values? The USEPA Region IV Screening Values for Saltwater Quality should be consulted as a source of action levels. Site releases may occur over an extended period of time. Exposures are expected to be chronic rather than acute; therefore,

chronic saltwater quality criteria should be used for action levels. The decision process leading to corrective action should be presented in detail. Indicators for each potential response should be outlined. Under what situation would work be halted?

*Action levels are based on EPA's Ambient Quality Criteria for water. Background values will be determined by the baseline monitoring effort, as well as upgradient samples (as appropriate). Killam feels that site releases to surface water from construction activities will occur over a short period of time. Clearly, excursions at or above trigger levels would be short term phenomena, since corrective actions would be triggered. In Killam's opinion, trigger levels should be based on acute water quality criteria. If trigger levels are exceeded, the cause of the exceedence will be investigated and corrected immediately, if possible. Work will be halted if the exceedence could not be corrected.*

**Comment 45. by LAW**

Section 3.0 - Trigger or action levels for ground water should consider potential impacts on surface water quality. Ground-water discharge to surface water is the migratory pathway of concern. A dilution factor may be applied to surface water criteria. In addition, background values should be considered in setting action levels.

*Killam's approach to establishing groundwater trigger levels involves applying a dilution factor to the groundwater, then comparing the resulting levels to chronic surface water criteria (since groundwater discharges are long term). Background values are utilized in establishing an increment of allowable increases in contaminant concentrations (150% of background would be permitted, unless trigger levels based on surface water criteria were numerically larger).*

What types of containment upgrade for ground water are envisioned? The responses listed in Section 3.4 appear to address control of releases to ground water, not releases of ground water to other media.

*In addition to the responses listed in Section 3.4, the City is evaluating the inclusion of an additional containment measure, which would require the injection of a drilling mud in the borehole as the augers are removed. This mud would tend to keep contaminants out of the borehole and minimize any transfer of water, soil, or product through the borehole.*

The locations of the additional monitoring wells appear to be in areas of contamination. Installation of the wells may open a migratory pathway for constituents present above the sand aquifer. The value of these wells should be examined carefully.

*Use of proper well installation protocols should minimize this risk.*

**Comment 46. by LAW**

Lead was detected at a maximum concentration of 43,600 mg/kg in Horizon A soils. The proposed TWA revision for inorganic lead is 0.05 mg/m<sup>3</sup>. Using the method described on page 10, the acceptable dust concentration may be as low as 1.1 mg/m<sup>3</sup> total particulate. Therefore,

the OSHA guidelines are not protective. A level of 2 mg/m<sup>3</sup> for total particulate is recommended in order to insure an adequate margin for safety.

*Law is correct in stating that the maximum detected concentration of lead (at 43,600 mg/kg) in Horizon A results in an acceptable dust concentration of 1.1 mg/m<sup>3</sup>. However, it should be noted that the cited lead concentration can be considered to be an outlier. In all 80 samples were analyzed for lead in Horizons A and B. Of these, the worst 10 samples are shown below, along with corresponding acceptable dust levels.*

Concentration (mg/kg)	Acceptable Dust Level (mg/m <sup>3</sup> )
43,600	1.15
16,200	3.09
5,480	9.12
2,960	16.69
2,290	21.83
1,530	32.68
1,230	40.65
893	55.99
890	56.18

*This indicates that for all but the two highest samples, the OSHA guidelines are adequately protective. Killam believes that the highest lead levels found are sufficiently uncommon that they would not represent an area dust source offering a risk to site workers at levels below the OSHA guideline. Therefore, while Law is correct in identifying an error in identifying the highest concentration of lead, the OSHA guideline for dust remains appropriate for this site.*

Comment 47. by SCE&G, NPS

Killam should clarify that initial pile driving will be suspended long enough to allow groundwater sampling and evaluation against action levels. A pilot test pile program is recommended to monitor the effectiveness of the containment system.

*For the record, following the installation of the initial pile cluster (which is essentially a full scale test), pile driving will be suspended until the monitoring well can be pumped, sampled, and tested.*

Comment 48. by SCE&G

One or two days of pumping is irrelevant since a pumping fate is not presented. A more significant measure to assure groundwater sampling is volume pumped. Calculations for hydraulic conductivity, porosity, gradient, etc. should be presented after a distance is determined between the early warning well and the initial pile driving cluster is known.

<sup>08</sup>Killam

*One or two days was the presented as the probable time required to achieve the pumping of the required volume of water. Killam agrees that volume pumped is the critical determinant in this case. Calculations which justify the specific volume will be presented following the installation of the well.*